Seventeenth Annual Report

OF THE

North Dakota Agricultural Experiment Station

Agricultural College, North Dakota

TO

The Governor of North Dakota

1907

FARGO, N. D.
Walker Bros. & Hardy, Printers
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LETTER OF TRANSMISSAL.

Agricultural College, N. D. February 1st, 1907.

Hon. John Burke, Governor of the State of North Dakota.

Sir:—As required by Act of Congress, approved March 2, 1887, I hereby submit the Seventeenth Annual Report of the North Dakota Experiment Station for the year ending February 1st, 1907, together with a financial statement of receipts and disbursements, as required by law, for the government fiscal year ending June 30th, 1906.

Very respectfully yours,

B. N. STONE,

President Board of Trustees.

STATION STAFF

J. H. Worst, LL. D. ..... Director
E. F. Ladd, B. S. ..... Chemist
C. B. Waldron, B. S., ... Horticulturist and Entomologist
H. L. Bolley, M. S. ..... Botanist
J. H. Shepperd, M. S. A. ..... Vice Director and Agriculturist
L. Van Es, M. D., V. S. ..... Veterinarian
O. O. Churchill, B. S. ..... Assistant in Plant Breeding
Fred J. Pritchard, B. S. ..... Assistant Botanist
W. B. Richards, B. S. A. ..... Assistant in Animal Husbandry
Clifford D. Holley, M. S. Ph. D. ..... Assistant Chemist
Adele Shepperd ..... Assistant Chemist
J. C. McDowell, B. S. A. ..... Assistant Agriculturist
E. G. Schollander, B. S., ... Supt. of Demonstration Farms
C. M. Hennis ..... Farm Superintendent
W. L. Lanxon ..... Herdsman
C. E. Nugent ..... Acountant
O. A. Thompson, B. S. ..... Supt. Edgeley Sub. Station
L. R. Waldron, M. A. ..... Supt. Dickinson Sub. Station

BOARD OF TRUSTEES

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L. B. Hanna, Treasurer ..... Fargo
J. P. Brodie (Special member for sub-experiment station at Dickinson) ..... Dickinson

REPORT

To the Board of Trustees of the North Dakota Agricultural College and Experimental Station:

Gentlemen:—I have the honor to submit herewith the seventeenth annual report of the North Dakota Government Experimental Station.

The following bulletins were published during the year:

No. 68	Rust Problems Facts, Observations and Theories Possible Means of Control	Henry L. Bolley F. J. Pritchard
No. 69	Foods and Food Products Whiskey and Other Beverages Drugs and Medicines	E. F. Ladd
No. 70	Paints and Their Compositions	E. F. Ladd C. D. Holley
No. 71	Flax Culture	H. L. Bolley
No. 72	Bleaching of Flour	C. D. Holley E. F. Ladd
No. 73	Fattening Steers on Barley and Rejected Wheat	J. H. Shepperd W. B. Richards
No. 74	Hints to Homesteaders.	L. R. Waldron, Supt. Dickinson Sub-Station

DEMONSTRATION FARMS.

During the past year six miniature farms were operated for the purpose of demonstrating the value of good plowing and thorough cultivation of the soil, manuring the land and rotation of crops. Three of these farms are located on the line of the

Great Northern railroad viz.—at Ross, Ward Co., at Granville, Pierce Co., and at Lakota, Nelson Co. On the line of the Northern Pacific railroad one farm is located at Beach, Billings Co., one at New Salem, Morton Co., and one at Bismarck, Burleigh Co.

With the owner of each of these farms the experiment Station entered into a five year contract, the owner agreeing to farm the land and maintain the rotation as directed, the Station in most instances providing the seed grain, especially the corn and clover seed. The purpose of these farms is to put into practice the most approved methods of soil cultivation and system of crop rotation, taking into consideration soil and moisture conditions. To arrive at the best results these farms should be kept under the direction of the Experiment Station for eight or ten years. The number of demonstration farms should be increased to 12 or 18 and located in the different counties of the State. It is confidently expected that the Legislative Assembly will appropriate money for this purpose. No more feasible plan can be devised to bring the Experiment Station into direct and helpful relationship with the farmers and to exemplify the value of good farming in many farming communities, especially the value of growing clover or some other nitrogen gathering crop, and the cultivation of corn. The expense of operating a dozen demonstration farms would not be large, in view of the financial results that would follow. The Great Northern and the Northern Pacific railroad companies generously furnished the money to operate these farms during the year 1906, and Mr. E. G. Schollander of the Agricultural College superintended the work. The result of the season's work was very gratifying and a somewhat detailed acount is appended to this report.

TILE DRAINAGE

To test the value and effectiveness of tile drainage in the Red River Valley about 40 acres, situated in the northeast corner of the Experiment Station farm was tiled late last fall. To make the experiment possible a twelve inch sewer was constructed to serve as an outlet to the Red River at an expense of more than $2,000.00. This sewer enters the farm at a depth of 4 feet below the surface, and 4 inch tile, opening into this sewer are laid at right angles to it at intervals of 50 ft., 75 ft., 100 ft. and 200 ft., with sufficient fall to carry the water out. It is our purpose to seed the land in different kinds of grain in strips running at right angles to the drain tile, in order to determine the general effect of subsurface drainage and the effect, if any, of the different distances the tile drains are laid apart.

It is also our purpose to locate tile wells, five feet deep, at varying distances from the tile drains and to make daily measurements during the growing season to determine what effect the drains may have upon the soil water level.

The Division of Drainage Department of Agriculture, cooperated to the extent of furnishing $1,000.00 for making this experiment, which cost a total of over $3,000.00. The Government was represented by E. T. Stewart and the Experiment Station by Prof. C. B. Waldron, who gave the work intelligent supervision.

SEED TRAIN SPECIALS.

Seed train specials were operated during the early spring of 1906 on the "Soo," the Great Northern and the Northern Pacific railroads, under the auspices of the Farmer's Institute, arrangements having been made by E. E. Kaufman, Secretary of the Farmers' Institute Board. Every town of importance on the three lines of road enumerated was visited and short addresses delivered by members of the Experiment Station Staff and the Farmers' Institute lecturers, covering such practical subjects as seed treatment for prevention of smut and other diseases, seed selection, seed testing, crop rotation, value of cultivated and leguminous crops, thorough cultivation, etc. Thousands of information bulletins were distributed among the farmers on these trips. The railroads made generous provision by providing special trains for this work and in many ways contributing to the comfort of the speakers, the Great Northern lodging and boarding them at its own expense. The farmers everywhere manifested commendable interest in the effort to raise the standard of agriculture and to make improvement in cultivation methods and quality of seed grain used.

SUB-STATIONS

The Sub-stations at Edgeley and Dickinson have had successful years and contributed substantially to the State's fund of experimental knowledge. The varying soil and moisture conditions as represented by these stations enables the work of experimenting to be carried on without unnecessary duplication. It has been my policy, as Director, to confine the work of each station more particularly to those features wherein local conditions differ from those of other sections of the state. In this way all agricultural problems, in time, can be worked out most economically and without all working out problems that are common to all.

J. H. Worst, *Director.*

CHEMICAL DEPARTMENT

To J. H. Worst, Director:

Sir:—I herewith present my seventeenth annual report as Chemist of the North Dakota Government Agricultural Experiment Station, covering the calendar year 1906.

Work in the Chemical Department during the past year has covered a very wide range of subjects. This has been made necessary owing to the fact that this Department has been charged with the enforcement of the several food, drug, paint, formaldehyde laws, fertilizer law, etc., by acts of the legislature, in addition to the regular duties assigned to the Experiment Station.

Among the subjects especially investigated have been a study of the comparative value of lignite coal as a fuel, in a range especially adapted for burning lignite; Meteorological studies; analyses of water for citizens of the state; a determination of the strength of 219 samples of formaldehyde, as offered for sale in the state; analysis of nearly two hundred samples of paints, and oils; over 3,000 samples of food and drug preparations; a large number of cattle foods, and other agricultural products have been examined, and about 140 samples of oils and gasoline tested.

During the past year correspondence with the Department has been very heavy as will be indicated from the fact that during the year 5,003 letters have been written, in addition to a large number of circular letters, postal cards, and bulletins which were sent out.

There have also been prepared by this Department four Bulletins:

Special Bulletin Number 4, containing a compilation of the pure food law, pure drug law, pure paint law, together with the rulings bearing thereon, (22 pages.)

Bulletin Number 69 dealing with analysis of food products, drugs and patent medicines and various beverages, (50 pages.)

Bulletin Number 70, "Paints and Their Composition" (85 pages.)

The biennial report dealing with the examination of a large number of food products, formaldehydes, oils, and meteorological records (48 pages.)

Part II of the Station Report dealing with the subject of

food adulteration, beverages, drugs, patent medicines, oils, etc., (164 pages.)

Bulletin Number 72, "The Bleaching of Flour" deals with the question of the influence of bleaching as now practiced in flouring mills upon the quality of flours, and the effect upon the production of bread by the same, (17 pages.)

Much of the data resulting from these investigations will be found in the various bulletins and reports, and there is only included here the results of meteorological records.

SUMMARIES OF TEMPERATURE, RAINFALL AND SUNSHINE.

For the past sixteen years meteorological records at this station have been maintained. For each year data has been published in preceding annual reports, and for the present year we have the following data:

TEMPERATURE AND RAINFALL FOR 1906.

Month.	Mean.	Maximum	Minimum	Rainfall inc.
January	12.5	37.	-27	.62
February	7.8	40.	-32	.24
March	19.8*	61.	-16*	.38
April	46.6	82.	26	2.21
May	54.2	93.	29	3.03
June	63.4	87.	46	3.11
July	67.8	92.	48	2.68
August	67.6	97.	40	2.22
September	63.8	95.	37	1.18
October	43.8	81.	15	0.75
November	27.2	57.	-7	1.01
December	9.2	38.	-19	.27
Total	483.7	860.	140.	17.70
Average	47.3	71.6	11.6	1.47

*Owing to loss of records for minimum thermometer for March, the data inserted above is that given for the Moorhead Weather Bureau, which is usually very similar to the Fargo records.

From the above table, as compared with previous records, it will be observed that the mean average temperature for 1906 has been quite a little higher than for the preceding year when the mean average was 39.40 deg.

The rainfall for 1906, 17.70 inches, is very markedly lower than that for 1905 when the total rainfall was 30.76 inches, and the average for the past fifteen years has been 21.36 inches. It will thus be observed that the excessive rainfall of the preceding years has given place to rainfall below that of the average.

The annual rainfall since 1892 is shown in the following:

	1892	1893	1894	1895	1896
Rainfall, inches,	20.73	16.17	18.72	16.05	21.77

	1897	1898	1899	1900	1901
Rainfall, inches,	22.50	16.36	21.20	25.54	25.68

	1902	1903	1904	1905	1906
Rainfall, inches,	23.16	23.81	20.26	30.76	17.70

This gives an average rainfall of 21.36 inches for the past fifteen years, with a minimum of 16.05 in 1895 and a maximum of 30.76 in 1905.

MONTHLY RECORD OF SUNSHINE.

The record of the sunshine as taken at this station is by means of a Friez Photographic Recorder, but without correction for the early morning and evening sunshine which is not fully recorded by this instrument.

SUNSHINE RECORD, 1906.

Months	Total Hours		Hours Daily Means		Percentage of
	Possible	Recorded	Possible	Recorded	Possible Sunshine
January	279.10	114.7	9.00	3.70	40.77
February	287.10	155.8	10.25	5.57	54.21
March	369.00	173.4	11.90	5.59	46.77
April	40.73	158.4	13.50	5.28	38.76
May	456.30	153.8	14.71	4.96	33.70
June	475.00	180.4	15.83	6.01	37.97
July	480.20	264.6	15.49	8.53	54.90
August	441.80	232.4	14.25	7.49	52.51
September	378.30	209.3	12.60	6.97	54.95
October	337.6	149.8	10.89	4.80	44.19
November	281.6	79.5	9.38	2.65	28.40
December	267.1	53.3	8.61	1.71	19.93
Means,	341.15	162.1	12.1	5.27	42.25

RECORD OF WIND VELOCITY.

There was installed at this station in January, 1906, on the tower of the building, a Friez Wind Guage with Anemometer Register. Beginning with the month of February the records are presented in the following table.

The total means are for the twenty-four hours from midnight to midnight, but the maximum velocity is for the twenty-four hours preceding twelve o'clock each day and, therefore, does not correspond to the hours for the mean velocity.

	February, 1906			March 1906		
Date	Max Velocity	Mean Velocity	Total Miles	Max Velocity	Mean Velocity	Total Miles
1	13	11.7	281	38	25.6	616
2	40	16.7	402	44	36	864
3	55	32.6	784	39	33.2	797
4	17	17.3	437	22	13.2	317
5	13	8.0	193	21	11.9	287
6	37	11.2	271	16	11.8	284
7	35	23.5	565	14	11.7	283
8	29	9.2	221	37	13.7	330
9	29	16.3	394	33	29.3	705
10	33	19.7	474	29	23.5	566
11	21	17.7	425	15	12.5	301
12	33	5.8	141	25	6.8	164
13	31	22.8	549	29	19.4	466
14	27	10.8	260	11	8.0	192
15	30	25.5	614	18	7.5	180
16	21	16.7	403	18	14.3	345
17	24	11.8	285	18	11.8	285
18	24	11.8	285	22	14.7	354
19	30	17.3	416	25	12.5	300
20	32	22.3	536	41	23.0	554
21	30	15.6	371	32	28.2	679
22	25	16.9	406	18	9.2	221
23	29	7.9	191	33	13.9	336
24	22	18.0	434	35	30.0	722
25	17	8.2	199	27	22.8	549
26	17	11.8	285	21	16.1	387
27	29	13.1	335	21	9.2	221
28	29	17.0	408	20	14.2	343
29				14	7.1	172
30				24	11.2	270
31				30	10.3	248
Means and totals,		15.6	10,566		17.0	12,348

WIND RECORD.

Date	April, 1906. Max Velocity	Mean Velocity	Total Miles	May 1906. Max Velocity	Mean Velocity	Total Miles
1	32	23.8	572	24	13.0	323
2	40	25.2	607	21	11.9	287
3	28	25.7	617	39	17.0	409
4	20	9.1	220	27	13.3	330
5	32	16.9	406	29	20.5	492
6	15	13.5	324	17	12.1	291
7	18	11.9	287	22	9.2	223
8	16	10.7	257	23	16.1	388
9	23	13.7	330	21	8.4	202
10	19	11.1	268	25	13.3	320
11	24	12.2	293	36	19.0	457
12	35	29.6	472	36	24.8	597
13	35	30.2	725	26	18.0	432
14	29	23.8	572	30	17.2	414
15	22	10.4	250	31	21.3	513
16	37	19.0	458	38	15.4	370
17	39	26.5	636	47	18.7	450
18	33	17.3	417	35	29.9	718
19	24	11.1	268	10	7.7	185
20	27	15.0	361	13	7.5	182
21	33	18.0	432	25	8.7	209
22	34	11.5	277	24	17.3	416
23	35	27.0	649	23	15.8	381
24	26	24.0	578	19	12.9	310
25	25	14.7	354	38	22.5	541
26	13	8.7	211	25	21.0	506
27	10	9.5	230	12	8.0	194
28	14	7.6	185	26	9.9	238
29	9	7.5	181	33	20.5	492
30	17	6.3	153	35	27.0	650
31				16	17.6	423
Means and totals,		16.3	11,590		15.9	11,943

WIND RECORD.

Date	June, 1906			July, 1906.		
	Max Velocity	Mean Velocity	Total Miles	Max Velocity	Mean Velocity	Total Miles
1	23	7.3	176	21	10.8	261
2	28	16.3	392	22	15.0	360
3	10	8.7	210	15	9.1	219
4	9	6.3	152	15	8.9	215
5	30	8.6	207	10	7.2	174
6	54	25.5	612	15	8.5	206
7	52	43.8	1,053	16	11.7	283
8	25	23.2	588	10	8.7	211
9	25	17.1	411	8	6.4	155
10	7	5.6	135	26	8.8	213
11	24	4.9	118	30	17.9	431
12	26	18.6	448	18	9.2	222
13	30	22.0	529	13	6.4	154
14	24	17.4	418	21	11.0	264
15	17	9.7	234	17	10.4	250
16	27	13.2	317	12	10.5	253
17	14	12.7	307	18	5.9	143
18	12	8.0	192	26	15.3	368
19	25	9.2	221	13	9.3	225
20	28	17.9	431	20	12.5	300
21	28	20.5	492	26	10.7	259
22	17	11.5	277	27	16.0	384
23	12	7.2	173	13	9.1	220
24	11	7.2	174	24	11.3	273
25	11	6.5	156	27	16.2	389
26	8	4.4	106	15	5.2	125
27	20	7.1	172	16	11.6	279
28	27	16.0	386	23	12.0	288
29	32	19.2	463	23	5.6	135
30	23	12.2	303	12	9.4	227
31				21	8.3	201
Means and totals,		13.6	9,853		10.6	7,687

WIND RECORD.

Date	August, 1906			September, 1906.		
	Max Velocity	Mean Velocity	Total Miles	Max Velocity	Mean Velocity	Total Miles
1	21	16.7	403	27	17.7	425
2	22	13.4	323	16	11.5	276
3	15	7.2	174	30	9.6	232
4	9	6.6	159	35	20.8	500
5	7	5.3	128	23	10.2	245
6	10	6.2	149	24	16.5	396
7	10	7.2	174	16	13.0	313
8	9	7.2	175	18	9.3	224
9	16	5.2	125	19	12.4	298
10	18	10.3	249	31	15.7	279
11	14	8.0	192	14	7.1	172
12	20	14.0	338	16	7.7	185
13	22	15.5	374	38	10.4	251
14	27	18.1	435	41	30.1	723
15	22	13.2	318	33	24.7	595
16	15	5.6	136	13	8.2	198
17	16	12.8	308	11	5.0	122
18	23	12.8	309	9	6.7	163
19	26	15.5	374	11	6.0	146
20	25	21.6	520	21	7.6	184
21	17	13.4	323	13	9.7	233
22	22	14.7	354	21	12.0	289
23	13	9.4	226	34	16.4	395
24	11	4.7	113	43	27.9	670
25	23	9.0	216	25	14.7	355
26	23	14.2	342	25	16.3	393
27	23	15.0	360	30	20.0	481
28	26	10.5	253	15	15.0	367
29	29	16.9	407	33	8.7	209
30	13	7.6	184	37	23.0	553
31	26	12.7	207			
Means and totals,		11.3	8,348		13.7	9,872

WIND RECORD.

Date	October, 1906.			November, 1906.		
	Max Velocity	Mean Velocity	Total Miles	Max Velocity	Mean Velocity	Total Miles
1	21	9.6	231	39	27.9	671
2	27	12.8	309	18	14.7	355
3	39	23.1	555	18	11.7	282
4	24	15.5	372	21	9.0	216
5	23	12.0	288	24	15.1	363
6	36	16.4	394	18	10.5	254
7	41	9.6	232	22	9.2	221
8	47	31.9	766	24	19.2	462
9	28	17.5	420	25	16.8	405
10	26	8.6	207	23	9.7	233
11	27	21.8	524	20	14.8	357
12	24	20.2	485	34	8.6	208
13	20	11.6	280	31	23.2	557
14	22	11.3	273	17	9.6	232
15	24	17.6	423	28	12.9	310
16	39	23.1	555	13	15.4	370
17	34	22.2	533			
18	16	8.6	208			
19	23	11.7	282			
20	29	19.8	476	15		
21	15	13.6	327	12	8.9	215
22	17	8.5	206	15	7.5	180
23	16	9.5	229	21	12.1	315
24	14	9.4	227			
25	16	10.2	245	27		
26	32	15.8	380	29	20.5	492
27	25	20.0	482	29	17.5	420
28	30	12.0	288	32	12.7	305
29	21	16.3	392	40	21.3	513
30	28	8.04	193	28	21.6	520
31	35	23.5	564			
Means and totals,		15.21	11,346		13.4	8,456

WIND RECORD.

December, 1906.

Date	Max Velocity	Mean Velocity	Total Miles
1	26	14.1	340
2	27	10.4	250
3	27	15.0	361
4	26	16.3	392
5	45	17.1	411
6	29	24.5	589
7	30	17.4	419
8	25	17.6	423
9	19	9.5	228
10	24	6.7	162
11	27	18.5	446
12	36	16.7	403
13	33	17.7	426
14	35	23.7	571
15	28	16.7	403
16	12	14.2	343
17			153
18			
19			
20	26		
21	14	11.5	277
22	22	4.1	102
23	28	18.5	445
24	29	27.0	649
25	23	11.2	269
26	23	15.4	371
27	23	14.5	350
28	24	9.29	223
29	28	19.8	476
30	30	20.2	485
31	31	22.2	529
Means and totals,		15.91	10,496

The total number of miles recorded for the eleven months beginning February 1st have been by months as follows:

February,	10,566	Miles
March,	12,348	"
April,	11,590	"
May,	11,943	"
June,	9,856	"
July,	7,687	"
August,	8,348	"
September,	9,872	"
October,	11,346	"
November,*	8,456	"
December,**	10,496	"
Total,	112,508	"

*In the month of November the record was lost for six days.
**There was lost the records for four days during this month.

EVAPORATION FROM A WATER SURFACE.

For four years preceding the present there has been published a record showing the daily evaporation of water from a water surface for the principal growing months. Distilled water was employed and the experiment was conducted as outlined on page 20 of the Thirteenth Annual Report of this Station.

For the months of May to September, inclusive, of the present year the record is as follows:

Date	May	June	July	August	September
1	.03	.00	.19	.19	.20
2		.10	.00	.00	.10
3	.15	.17	.00	.10	.20
4	.21	.10	.21	.10	.14
5	.11	.01	.20	.05	.36
6	.12	.10	.10	.05	.20
7	.10	.16	.20	.28	.30
8	.05	.10	.20	.10	.20
9	.10	.01	.10	.10	.20
10	.10	.17	.20	.20	.10
11	.30	.20	.30	.30	.23
12	.30		.10	.20	.18
13	.40	.30	.20	.20	
14	.11	.30	.20	.30	.04
15	.02	.30	.10	.33	.06
16	.21	.30	.78	.20	.20
17	.09	.20	.20	.25	.10
18	.22		.10	.35	.10
19	.10	.09	.00	.30	.04
20	.00	.10	.20	.30	.06
21	.05	.10	.10	.30	.06

22	.10	.10	.40	.13	.10
23	.30	.10	.30	.01	.00
24	.00	.00	.20	.09	.11
25	.06	.01	.30	.02	.11
26	.00	.00	.16	.12	.15
27	.10	.10	.30	.10	.15
28	.10	.12	.04	.20	.10
29	.00	.13	.20	.04	.22
30	.00	.20	.10	.10	.10
31	.20		.16	.20	
Totals,	3.63	3.57	5.84	5.21	4.11
Average,	.11	.11	.18	.16	.13

The total amount of water evaporated from a water surface for the five months was 22.36 inches, a monthly average of 4.472 inches, and a daily average of .145 inches. This is considerably less than for the preceding years.

The summary for the past five years is shown for months in the following table:

INCHES OF EVAPORATION.

Month	1902	1903	1904	1905	1906
May	6.48	4.30	6.40	4.37	3.63
June	5.75	8.69	5.40	5.60	3.57
July	4.77	13.26	8.05	6.67	5.84
August	6.62	12.07	8.30	6.51	5.21
September	4.50	3.55	2.29	3.28	4.11
Total,	28.12	41.87	30.44	26.43	22.36

A wide range of difference is shown for the five years. The evaporation for the present year has been the lowest for the entire period, and when this data is examined in connection with other meterological data, especially the question of sunshine and relative humidity of the atmosphere much instructive information is afforded.

The rainfall for the same period is as follows:

INCHES OF RAINFALL.

Month	1902	1903	1904	1905	1906
May	4.25	2.78	1.47	5.77	3.03
June	3.97	.56	3.83	5.00	3.11
July	2.54	2.62	2.83	5.17	2.68
August	2.95	4.61	.69	6.82	2.22
September	1.61	5.61	3.49	3.47	1.18
Total	14.32	16.18	12.30	26.23	12.22

From the data presented it appears that in 1902 the evaporation was 1.96 times that of the total rainfall for the same period.

In 1903 it was 2.58 times as great.

In 1904 it was 2.47 times as great.

In 1905 the rainfall as compared with the evaporation was as one to 1.003. In other words the rainfall was practically equivalent to the total evaporation.

In 1906, however, the equivalent evaporation was 1.829 times the rainfall.

Evaporation as presented in the above table for the last five years shows a very wide range, and during the past year, both the rainfall and the evaporation from a water surface were the lowest for the period of observation.

RECOMMENDATIONS AND ACKNOWLEDGEMENTS

The analytical work given in these pages and in the various bulletins published by this Department has been in a large measure the work of my assistants, who have performed carefully and efficiently the duties assigned them by this Department. I desire therefore to commend them and the efforts put forth by each of them in furthering the work of the Department which has resulted in whatever of success may have been due to the efforts of this Department during the past year.

I further recommend that provision be made for installing the small experimental flour mill which was purchased during the past year. For this purpose a small building costing about $6,000 would best meet the needs of the institution and, at the same time, enable the Department to make the necessary investigations as provided for by the legislative requirements, and at the same time, would afford ample opportunity for students in the College to familiarize themselves with milling conditions and experimental work in connection with the testing and baking of flours.

During the coming year it is our desire to devote some time to the investigation of problems of alcohol production from waste farm products to be used for the purpose of denaturing, so to be consumed in fuel and power production upon the farm.

Respectfully submitted.

E. F. LADD,
Chemist.

DEPARTMENT OF BOTANY

Director J. H. Worst:

Sir:—The following is an outline of the work pursued in the Botanical Department for the season of 1906:

General Notes on Selection: Studies on selection as a means of gaining resistance in plants to disease have taken most of the effort during the past year. The main question under consideration is really to determine whether the resistance to disease which has been found to exist in various varieties of plants is individual, that is, whether it occurs by saltatory mutations, or whether this resistance is to be looked upon as racial, gained by gradual accretion from day to day, season by season. It is possible that it arises in both ways. The fact that new varieties that have been obtained by crossing often show a marked variation in this power of resistance, would indicate that resistance or immune varieties might best be obtained by efforts in crossing, thus producing individuals of quite new character from which new races (varieties) could be developed. The more marked results which follow proper selection within a race or variety, however, tend quite as strongly to show that great change may be made in a race through straight selection for a given quality. This work of selection is of the type or kind which any plant grower, farmer or gardner, can carry out. I have, therefore, persisted in placing most of the experimental work along this line with the view of determining what principles of plant improvement with reference to disease are directly available in farm methods.

It is possible that it may yet be proved that no permanent resistance can be gained by mere selection within a variety which, to start with, has no marked elements of disease resistance. If, however, this disputed point can be clearly disposed of either negatively or affirmatively it will tend greatly to clarify agricultural methods in plant breeding.

In this selection work there are two different lines to be pursued: (1) That of studies in grading within the race or variety. (2.) Direct selection and study of the character of individuals. In each case I have used the method of disease introduction in order to induce the greatest possible elimination, because of weakness, through disease, the idea being to save those plants which best survive, reach the highest standards of perfection under the severest conditions of disease.

Special attention has been given to three general field crops,—potatoes, flax and wheat. The diseases of wheat concerned are rust, smut and blight; the diseases of flax,—rust, wilt, and boll disease; the diseases of potato,—rot, and the various types of blight.

Increase and Distribution of Resistant Seed: Since the announcement of the first work in the line of crop breeding for resistance or immunity, the Department has received many requests for "immune" or resistant seed. Many make requests for seed in large quantities, and others ask only for small lots. These requests show the importance of this line of study, and that when principles of cereal cropping have been really established for this sort of work, the farmers will in a large way be ready and appreciate the value.

In the case of flax and potatoes, the development of resistance seems to be in direct proportion to the amount of disease in the soil. It would be difficult for us, even should we desire to do so, to increase the seed to any great extent for distribution simply from the lack of sick land area and a working force to develop a larger crop true to its resisting qualities. As yet we are not prepared to give out seed. Our work is intensive with the view of establishing principles upon which farmers may work and do likewise. So far as we have studied the matter, especially in flax, resistance may be developed in any strain or variety. The essential features of the work are *patience, home-growing of seed, and the saving of the best seed which is produced under the home-grown conditions.* In the case of flax, for example, the principle of gaining immune seed, as it now stands, may be stated as follows: Having a race or variety of flax you desire to grow, seed it on your own land, and if that land should chance to be flax-sick save the seed which matures even though it be a very poor yield and apparently poor in quality. Grade these seeds to the plumpest form and sow it back on the same land, continuing the process as often as a sensible principle of rotation will allow. Since such flax seed will bear some spores of disease, if this seed is to be used on new land, it would be a matter of common sense to treat it by the formaldehyde method, as this not only prevents the introduction of more disease but strengthens the germinating power of the seed because it kills other moulds and fungi that may pray upon the young plant. Working after this manner any farmer can develop a strain of highly resistant flax, provided his land is already sick. If his soil is not already sick he is still working along right lines of cropping to get the greatest possible yield. If he brings in flaxseed from land that does not have the disease and his land does

have it then he can expect little or no crop for such seed will not be largely resistant to the disease in his soil. If he grades his own seed to the best every year, he is simply discarding the weak and shrivelled seeds from plants which are unable to withstand the disease with the counter result that he plants the seeds from parent plants which show resistance. Should our work lead to the chance discovery of a race or strain of seed which shows an ability to permanently maintaining resistance to disease regardless of local conditions under which it is grown, we will certainly not be negligent to increase it and the Station farm will be able to give it out as in the case of other improved seeds.

While we have undoubtedly gained flax plants practically immune to wilt and wheat plants which show marked resistance to rust, and potato plants which show great powers of resistance to the ordinary potato diseases, there is yet no fixed proof that such resistant strains will maintain their resistance except they be farmed in the manner through which the resistance was first gained. In studies upon this question we plant numerous strains of seeds, those which show the poorest resistance as well as those which show the greatest, subjecting each to the same methods and conditions,—soil infection, seed infection and plant infection. We then strive to give those conditions of moisture and other environments which will produce the greatest possible amount of disease. Observation of the work proves conclusively that where one continues to select the poorest resistant grain or seed there is rapid degeneracy in yield, indeed in all qualities that indicate vitality. In the case of persistent selection along the line of increased vigor there is noted a progressive variation and the plants show marked increased powers of resistance to the prevailing disease. In this sense resistance to disease may not be a quality in itself but only an index of greater vital force against which disease producing fungi are ineffective.

This season there have been more marked results in the experiments tending to show that this may be the proper interpretation. It has been observed, for example, in the case of immune or resistant flax, that the immunity is largely decreased or less when any conditions are interposed which break down the general vitality of the plant. This has also been noted in the case of wheat and potatoes.

Principles or Methods in Farm Work: The studies upon resistance to disease have added further proof and confirmed the following conclusions as to proper farm methods in handling cereals:

(1) Home-growing of seed is an essential to highest crop improvement. (When proper methods of grading are followed this tends to fit a plant or crop to its environment, the average yearly conditions.) (2) Grading to evenness of seed quality results in

gradual increased yields, this last feature is so apparent that no farmer or grower can afford to ignore it. When seeds are thus evenly graded each plant gets an even start with every other plant, doing away with the feature of irregular competition among the members of the crop, and in many ways lessening the chances for disease development.

POTATO SELECTION: In the work with potatoes sixty odd selection strains were under test in 1905. Sixty seven were under trial in 1906. Every effort is made to give evenness of culture and care of seed from the maturing period to the following planting season, storage, etc. There was almost an even increase in the yield and strength of growth, and apparent resistance to disease noted in the strains for the crop of 1906 over that of 1905.

Farm Principles.—From this work with potatoes, though we may not be certain that the continual annual increase and improved apparent resistance is really due to disease resistance gain, we may nevertheless re-affirm the principle for farm work cited in a previous Bulletin No. 30; that *farmers should select potato tubers for seed for the following season from the vines in the field at digging time*, paying attention to the disease resistance shown by the respective vines and the quality and yield of tubers.

FLAX SELECTION: The work with flax is continued along two lines; (1) Plain selection for resistance to wilt and rust, and (2) Cross breeding between different strains of resistant flax. This last work is done not so much with the hope that some wonderful resistant hybrid may be obtained as to study the effects of cross-breeding upon the immune or resistant quality. In all 281 distinct strains or selection sorts were under test in 1905. Apparently but little has as yet been accomplished in the cross breeding work. The greatest difficulty appears in the fact that all cultivated flax varieties, races, seem to be a like subject to the wilt disease. This, however, does not seem equally true of the disease known as flax-rust (*Melampsori.*) Cross breeding work demands much time, but as it brings about great breaks in plant character, it is of course possible that this mode may yet give the surest road to disease resistance.

Flax Rust: In connection with the wilt studies a valuable discovery was made upon flax rust during the season of 1905 and 1906. Ordinarily this disease (caused by *Melampsori lini*) does but little harm upon seed flax, but on our breeding plots where continuous culture methods were conducted the rust became each season more destructive until many of the best wilt resisting strains were practically destroyed. The rust was so destructive upon our best resistant forms in 1905 that we concluded that the methods of se-

lecting to gain resistance to wilt had either weakened the plant with reference to resistance to rust, or that rust of flax is transmitted by the seed. Culture experiments conducted in culture cages seem to disprove the theory that rust can be transmitted by the seed.' Again, early spring studies of the straw and volunteer plants on our plots in cooperation with aid given by Prof. J. C. Arthur of the Indiana Station, allow us to make known the fact not previously known that the fungus of flax rust *passes all its different known spore stages upon the cultivated flax.* The disease is thus ready to attack the new crop at once in the spring, the infecting spores coming direct from the old flax-straw and stubble to the young plants. This seems to fully explain the great loss from rust in our experimental plots, and allows us to announce a new reason for proper rotation of flax soil and handling of the old flax straw.

Farm Principles Regarding Flax.—(1) *All rusty flax straw not thoroughly composted should be burned in order to destroy rust spores. Composting or burning will also destroy wilt Fusaria and other detrimental fungi.*

(2) *Rotation of soil must be practiced in flax culture in order to escape excessive rust infection, as the rust spores spread from the old straw and stubble to the new crop.*

These rust discoveries have greatly clarified the work of gaining wilt resistant flax. We now know that the destruction on our plots was probably not due to special weakness in the case of the wilt resistant strains, but because we had exposed the flax on those plots to intense rust infection by too continuous flax culture.

In 1905 new lines of selection were begun looking toward gaining rust resistance within the wilt immune strains. Very important observations were possible from the growths made in 1906. Great differences were noted in the different flax races (''varieties'') and even in the crop from individual plants. Some strains proved to be almost wholly resistant to rust while others proved practically worthless. Thus there would seem to be much hope of getting real resistance along this line of work.

WORK WITH WHEAT: In the work with wheat 401 different selection strains were under trial. In part of these the crop is handled and increased through the second and third year from the original individual. In other cases only select heads are propogated, and in others certain special methods of grading are practiced year after year upon seed from an original general field crop, as Scotch Fife, Blue Stem, Arnautka, etc. All plots are given every possible chance to become thoroughly affected with the common wheat diseases, in order that plants of weak resistance may be eliminated by selection or grading, as the case may be.

How Infected.—In the case of root rot and the various blighting troubles constant use of the same soil seems to give a sufficient source of infection. The addition of old straw and stubble, perhaps, helps this phase of the infection. In the case of smut and bunt (stinking smut) the seed is thoroughly blackened before sowing, while the rust infection is assured by the use of large quantities of the various types of spores in their season, both those of *Puccinia graminis and Puccinia rubigo-vera*... Barberry hedges and clumps are also interspersed amid the wheat plots. The influence of these bushes upon the development of *Puccinia graminis* is markedly apparent and very destructive. So greatly do they increase the virulence of *Puccinia graminis*, "stem rust," that strains of wheat previously thought to be highly resistant were so badly rusted in 1906 as to leave scarcely heavy enough seed for use the following year.

The past season, arrangements were made to dampen the wheat plots by a fine spray every evening at sun-down. The result of this work seems to have been effective in increasing the destructiveness of the rust. In regard to the work which is now being run along this line of selection for several years, it need only be said that the oldest selection strains are the most resistant and produce the plumpest and best yields of grain.

Soil Sterilization: In the spring of 1905 a plot of ground two rods square was selected in farm rotation plot No. 2, a plot which had been farmed continuously to wheat since the College had possession of the section and for at least thirteen years previous to that. The result of this continuous wheat cropping had brought the plot of ground to a condition in which practically no wheat ever matured. At harvest time there was usually little seed except only weeds. A steam food cooker was employed and by means of sacking the earth in gunnysacks deposited in a large cheese vat we were able to sterlize fourteen inches deep and one rod square of this plot. The earth was taken up in layers of about three inches ,each layer being kept separate, and was sterilized by steaming two separate times of two hours each on separate days. The earth was replaced in layers in the order taken out.

This sterilized area was seeded in 1905 to three different kinds of wheat the other rod square was given careful cultivation by deep spading, etc., until put in garden condition. Three samples of the same kinds of seeds as were seeded on the sterilized plot were sowed on this plot on the same day as a check. A very little wheat of poor quality was raised on the check plot and practically no grain produced upon the sterilized plot. The growth of straw on the sterilized plot was enormous.

In 1906 this whole experiment was duplicated, except only no

sterilizing was done this year. The yield of straw and grain on the original sterilized plot was above the normal growth of any near-by field crop. The straw lodged slightly, but not sufficiently to prevent filling. Exactly the same number of grains were planted on each plot. The yield from the sterilized plot, the second year after sterilization was found to be over one-third greater than that from the carefully spaded and properly handled non-sterilized ground and the grain was normal in form.

As yet I attempt no explanation, though it rather points to the conclusion that such soils have not been sufficiently depleted in fertility to acount for the depleted yields.

Prof. Whitney's Toxine Theory.—In this connection I would call attention to a theory proposed by Prof. M. C. Whitney of the U. S. Department of Agriculture, Division of Soil Investigation. Prof. Whitney has published one or more Farmers' Bulletins claiming that wheat and other crops produce toxine thus poisoning the ground against their own future growth. This is an alarming theory and needs much substantiation before it is given further notoriety. Our experiments on flax, potatoes and wheat, especially soil sterilization experiments and our experiments in continuous flax cropping all tend strongly to disprove Mr. Whitney's theories. Until he has actually produced a toxine for wheat or flax we shall yet have to believe that poor soil mechanics, soil depletion and fungus infestation of soils are the features which best account for lessened yields on soil under continuous cropping.

Green-house Cultures.—In order, however, that we may not make a mistake in these conclusions regarding the direct causes of crop depletion on such soils numerous pot and water-culture trials are being conducted in the Botanical culture-house, checking this question from numerous sides.

FERTILIZATION OF CLOVER AND ALFALFA: It is a common belief that red clover is fertilized almost wholly by bumblebees. Bumblebees are very scarce in North Dakota. In early days of clover growing here one could hardly find more than two or three bees per day in many acres of clover, yet clover always produces seed profusely in North Dakota. During the past season we carefully screened in a large area of red clover, one of white clover and one of alfalfa with wire screen of so small mesh that nothing larger than a mosquito could well penetrate. The screening was done before the plants came into blossom. Such covered beds stood in the open where they were well lighted by the sun and subject to wind. The plants grew uniformly, did not lodge or become damaged in any way. The results of the examinations of the matured heads showed that alfalfa could partly fill under such conditions but not so well as in the open. White clover filled approximately one-third

as well under the screen as in the open, and only one red clover head produced seed and that but one or two. The conclusions would seem to confirm the idea that at least some large insect is necessary for the fertilization of red clover, though it does not prove which one or ones. It is possible that breeding experiments and selection conducted under such cages may help to produce self-fertilizing types of legumes. The work will be continued another season.

TREE FEEDING AND MEDICATION: The tree feeding and medication experiment has been continued in a small way for the fourth season and is now carried sufficiently far to allow the statement that formaldehyde, copper sulfate and iron sulfate, when properly applied, tend to hasten the recovery of apple trees from sun-scald and sour-heart, and to check the development of apple blight and may hold plum-pocket (*Exoascus*) diseases well in check. Because of lack of time and insufficient orchard trees to work upon I am unable to lay down any general rules for application. It has been found that soil moisture, atmospheric humidity and the individuality of each tree determine the strength of the solution that may be used in feeding the tree. Feeding, if attempted, should be commenced as soon as the foliage is well formed. If one takes into consideration the individuality of trees and is in position to note the rate of feeding, formaldehyde may be effectively used in strength varying from one-half part to two parts per thousand of water, according to the speed with which each individual tree sucks up the solution. A rapid feeder cannot stand a strong solution for any great length of time. At present, it appears that a rather strong solution fed in a short time when the tree is sucking up the solution rapidly is more effective than a weaker solution extended over a longer period of time.

As to the method of applying the solution full directions are given in the 14th Annual Report of this Station. The aim is always to have the solution enter the tree through the heart wood.

As to control, no directions can be given other than to say that the feeder must observe the foliage and upon the first signs of leaf wilting or blighting a weaker solution should be substituted by the addition of water to that already in the feed container. As in the case of previous years plum and apple trees thus fed have produced more and better fruit, larger growth and sturdier foliage than checked trees. The chief difficulty in the way of this work becoming practical seems to be that each tree appears to be a law unto itself.

PLANT SURVEY: As much attention is given to the annual plant survey as the time at disposal will allow. A rather careful survey has been conducted by Prof. W. B. Bell of this Department

upon the Williston Irrigation area with the view of being able to appreciate, in the future, the effects of irrigation upon native plants.

Fungus Diseases.—Aside from the intensive experiments upon certain plant diseases the Department has continued to collect data regarding the distribution of other types of plant diseases, and in cooperation with the Bureau of Plant Industry has filed with that Bureau a short summary of the diseases most destructive in this state this year. It was observed that corn smut and the loose smut of wheat were more prevalent and destructive than in any previous season. We were unable to give any definite reason for this extra development of these two diseases, especially as the occurrence appeared to be general throughout the state. Arrangements have been made to conduct some definite experiments during the coming season to ascertain, if possible, the cause underlying this increase in the development of these diseases.

PUBLICATION: The Department has issued during the year 1906 bulletin No. 68 on "Rust Problems, Facts, Observations and Theories, and Possible Means of Control;" and Bulletin No. 71 on "Flax Culture." This latter bulletin is essentially the summary of a report upon the work resulting from European explorations of 1903. This Bulletin is sent out only upon direct application. The U. S. Department of Agriculture has issued essentially the same report as Farmers Bulletin No. 274, which may be had by direct application to the Bureau of Plant Industry, Washington, D. C. A bulletin on the Grass and Forage Plants of North Dakota tending to give some idea of their distribution and economic value is in course of construction.

WEED AND SEED LAWS: Because of pressing need that some organized effort be made to improve the standard of the agricultural and garden seeds sold in the state, and to hold in check the development of noxious introduced weeds, at your suggestion, I have made a draft of two separate laws, one looking towards regulating the sale, exposure and offering of seeds for sale and one calling for an effort to prevent the development and dissemination of the seeds of a number of our most destructive weeds. These laws are now before the Legislature for consideration.

HENRY L. BOLLEY,
Botanist.

AGRICULTURAL DEPARTMENT

To Director J. H. Worst:

Sir: In submitting to you the Seventeenth Annual Report of the Agricultural Department, it is a pleasure to state that no changes have occurred in the working force of the Department in positions higher than that of Farm Foreman. An almost complete change of expert field help has, however, been a serious handicap to the plant breeding work but the changes seemed unavoidable.

The demand for College extension work in the form of assisting in the introduction of agriculture in the public schools and of giving correspondence school work in agriculture have made such inroads upon the Assistant Agriculturist's time that he has not carried much consecutive work in soil moisture studies, although I had planned for him to make a comprehensive study of it.

The Assistant Animal Husbandman has put considerable of work upon the stock breeders' association and while it has required some time for him to do so, it has served an excellent purpose for the Station by acquainting him with the live stock conditions and problems peculiar to the state.

Farmers' institute and seed train meetings have been given some time by the writer and a considerable of time by the Assistant in Plant Breeding. I regard it an advantage to the Station work for a plant breeder representative of the institution to appear upon the platform as information relative to the performance of particular pedigreed varieties are thus secured in detail by means of personal interviews and criticisms of the strains produced are obtained, which could not be secured in any other way. Suitable cooperators in the work are thus enlisted better than could otherwise be done.

The correspondence of the Department has increased materially since I handed you my last annual report, but it is now divided between the different members of the force, until it is not a serious burden upon any individual, although it is no mean item when taken in the aggregate, while accounting for the time expenditure of the Department force.

Consultation and supervisory work with the Sub-Stations at Edgeley and Dickinson have been features of time expenditure by the writer.

The taking on of six demonstration farms in the drier districts of the state is an addition to the work undertaken, prior to the past

season, which has been well provided for by the addition of Mr. E. G. Schollander to our force of experimenters. The work carried on upon the demonstration farms is rather more of a research study than a demonstration as a thorough study of evaporation, water movement, and crop requirements upon the different classes of soil is being worked out. Manured and non-manured plats are studied upon each farm. Soil moisture movements and losses together with meterology observations, at each demonstration farm in addition to mechanical and chemical analyses of the soil and subsoil of each were made when these cropping trials were begun and are features that lay a foundation for a thorough comparative and scientific study of the effects of different systems of cropping. I particularly commend these demonstration or cooperative farm studies as they offer a splendid field for a scientific and practical study of soil exhaustion, moisture movement, moisture losses, the adaptation of different varieties to particular soils and climatic differences represented in the various districts of the state as well as to form an object lesson for all farm producers in their respective communities.

The work in grain breeding has not received the time which its importance merits, but it has been given all of the attention which could be spared to it. Wheat has been cross bred with emmer in a study of the effect of hybridization and in an endeavor to secure a strain upon which the chaff will hold well enough to prevent a loss from shelling and from a reduction of the grade as a result of bleaching while in the head. The study designed to produce a strain of wheat with uniform stooling habits and with culms and heads of similar height and development has been realized upon to a gratifying degree. The points of yield and grade which have so constantly been sought in connection with the other features named has also made progress. The work of breeding an awnless durum wheat is now an accomplished fact, although it will require time to determine the yielding, strength of straw, grade, chaff, holding capacity and other points, which are necessary features in a practical variety for general culture.

The work with oats has been breeding for thin hulled strains, those free from pin oats and for stiffness of straw and rust resistance as well as general uniformity in stooling, height and development of the clums and heads. With barley the work has been to secure plump bright strains with the desirable features already described for oat and wheat strains. In the work of flax breeding yield and grade have been the chief features sought. Especial attention has been given to the amount of branching and the number and size of bolls produced. The strain selected for fibre holds the character of great height tenaciously having reached a length

of four feet where single plants were given sixteen square inches to grow upon. The best plant reached a height of thirty-six inches before throwing out a single branch. The fibre strain is given little attention on account of the lack of opportunity to dispose of the product, but the strain is created and will be kept in stock. Millet plants have been divided into three strains by selection. One a seed producing plant, one a strictly hay type of plant and the third a combination hay and seed producing strain. The differentiation has been very marked.

Work has been started upon red clover and alfalfa but has not progressed far enough to give results.

The spring season of 1906 was so wet and backward that seed of the breeding corn was not planted as it was so late before corn seeding was possible that there was little chance for it to ripen normally. A bulletin which is almost ready to submit to you discusses fully the field trial work with all cereal crops.

Considerable amounts of the seed of improved flax, two-rowed barley, six-rowed barley, early oats, and emmer have been distributed to growers in the state.

Rotation of crop trials have been continued in the study of yield, their encouragement of weed growth and the yield and grade obtained in the crop. A study of clover and alfalfa varieties and of different sources of seed of the same varieties was carried on in 1906. A trial of seeding these crops with and without a nurse crop of wheat and broadcast as against drilling them in with a drill was begun.

The investigation of the results which can be secured, in yield, from the use of commercial fertilizers and stable manure have been continued and are reported upon in cereal bulletin mentioned above.

Drainage studies have been inaugurated, forty acres of tile having been laid with the latterals at intervals of from fifty to two hundred feet and at a depth of from two to four feet. Tile wells are to be placed at regular points beside the drains and midway between them where the depths are two, three and four feet respectively and where the parallel lines are at different distances apart at the above named depths. An investigation of the physical structure of the soil traversed by the drains will also be made a part of the study. The possibility of puddling the surface will be a feature for study. A daily measure of the water table in the tile wells established will be made throughout the growing season, which together with a comparison of the yields secured upon the tile drained land as against similar adjoining plats not tile drained should form data of unusual interest and value.

A study has also been begun of the time the land normally

thaws out in the spring and a study will be made of the length of time which the tile drains will flow, whether there is a tendency for them to be closed with ice, whether freezing bursts or cracks the tile and how much ice forms above them in the winter, also at what time they become active and effective in the spring.

Cattle fattening upon barley as compared with corn in a cheaply constructed shed for shelter is being carried out with a car load of feeding steers. A similar comparison in feeding pigs is in progress except that the latter have good quarters.

A number of cross breeding experiments with swine is also being carried on, which is proving an interesting and practical feature of work that is already showng marked effects upon a fecundity and offers a broad field for study in prepotency and hereditary traits.

The sheep work both in cross breeding and grade breeding is showing some very interesting and practical results.

POULTRY REPORT FOR 1906.

EGG RECORD BY MONTHS.

January	179
February	676
March	1127
April	1572
May	1644
June	1052
July	926
August	1035
September	795
October	236
November	21
December	41
	9304 or 775-1-3 doz.

EGGS SUPPLIED TO FARM HOUSE.

January—19½ doz. at 30 cts.	$ 5.85
February—39¼ doz. at 30 cts.	11.92
March—84 doz. at 25 cts.	21.00
April—78 doz. at 15 cts.	11.70
May—81 doz. at 16 cts.	12.96
June—72½ doz. at 17 cts.	12.32
July—75¼ doz. at 19 cts.	14.30
August—68 doz. at 20 cts.	13.60

September—51 doz. at 21 cts	10.71
October—45 doz. at 24 cts	10.80
November—31 doz. at 30 cts	9.30
December—10 doz. at 40 cts	4.00
	$138.46

UNDRESSED POULTRY SUPPLIED TO FARM HOUSE.

January—65 lbs. at 12 cts	$ 7.80
February—43½ lbs. at 12 cts	5.22
March—56½ lbs at 12 cts	6.78
April—14 lbs. at 12 cts	1.68
August—9 lbs. at 13 cts	1.17
September—59 lbs. at 10 cts	5.80
October—80 lbs. at 8 cts	6.40
November—55½ lbs. at 8 cts	4.44
December—34 lbs. at 9 cts	3.06
415½ lbs.	$ 42.35
Oct. 17—Domestic Science Dept.—23½ lbs. poultry at 8 cts	$ 1.88

EGGS SOLD.

42½ doz. of market eggs	$ 7.93
11 settings at $1.00	11.00
	$ 18.93

SALE OF BREEDING STOCK.

4 S. C. Brown Leghorn Cockerels at $1.50	$ 6.00
1 S. C. Brown Leghorn at	2.50
5 Barred Rock Cockerels at $1.75	8.75
1 Barred Rock Cockerel at	1.43
6 Barred Rock Hens at 50 cts	3.00
	$ 21.68

RECORD OF HATCHING—1906.

Natural Means:	
Eggs set under Hens	552
Eggs broken in nest	28
Infertile eggs or died in embryonic stage	201
Number of chicks that died while breaking shell	40

Number of strongly fertile eggs	328
Number of chicks	283
Hatching per cent	51
Artificial Means:	
Eggs placed in incubator 1st hatch	50
" " " " 2nd "	100
Total number of chicks	80
Hatching per cent 1st hatch	50
Hatching per cent 2nd hatch	65

LOSSES AMONG THE MATURE STOCK—1906

Number of deaths—Leghorns	7
Number of deaths Barred Rocks	15
Number of deaths grades	6
Barred Rock pullets stolen	8
	36

SUMMARY.

Eggs supplied to Farm House	$ 138.46
Poultry for Farm House	42.35
Poultry for Domestic Science Department	1.88
Sale of Eggs	18.93
Sale of Breeding Stock	21.68
Total	$ 223.30

INVENTORY TAKEN JANUARY 1, 1907.

Kind of Bird	S. C. Brown Leghorn	Leghorn R. C. Brown	Barred Plymouth Rocks	Grades	Total
Pullets		22	46	11	79
Hens	25	1	32	10	68
Males		7	15	2	24
Totals	25	30	93	23	171

EXPERIMENTAL WORK NOW IN PROCESS WITH POULTRY.

1. A trial in grading up from mongrel stock by the use of pure Barred Plymouth Rock sires. Selections are made in each cross from birds more nearly approaching Barred Plymouth Rock type. Four top crosses have been obtained.

2. The second year of a competitive laying trial between a pen of Barred Plymouth Rocks and a pen of Brown Leghorns.

3. The second season of a comparative trial between a pen of Barred Rock pullets in the main poultry house and a like pen of birds kept under rather rigorous conditions in a small single boarded outhouse.

4. The individual laying records of 44 Leghorns and Barred Rock pullets are being established by means of trap nests. The object in view is the selection of the best layers for breeding purposes. The individual records of the grade pullets in the grading "up" trial are also being tabulated.

5. In and in-breeding trials are planned in which pure bred males will be mated to females of varying relationships and the effect on the size and prolificacy of the offspring observed.

6. A breeding trial is being carried out in which a pure bred male is mated to grade females carrying varying percentages of pure blood. Comparisons of the type and productiveness of the progeny will be made.

NEEDS OF THE DEPARTMENT.

The most urgent need of this Department is a seed house, the erection and equipment of which should cost fifteen thousand dollars ($15,000.00.) With the present lack of storage facilities good seed grain of high pedigree value has to be used as commercial grain and the number of promising new strains must be limited by reason of a lack of a suitable storage place. Another source of serious trouble at present arises from the fact that the better seed grain is open to the ravages of vermin and to the careless visitor who handles and inadvertently mixes the different sorts. It is impossible, with our present facilities, to cure much seed corn or to get accurately the dry weghts of the fodder of the less mature varieties. Poor facilities for cleaning, treating and sorting the grain not only limit the amount of work but cause frequent costly accidents on the part of the workmen by reason of their crowded condition and the lack of floor space which can be assigned to their exclusive use.

Steer and sheep feeding barns and equipment are badly needed for the prosecution of that important line of study and I would recommend that an appropriation of five thousand dollars ($5,000.00) for that purpose. The fact that much of the crop producing area of the state will yield as much small grain and grow a crop of corn every fourth year as it does when fallowed or when no change is made from small grain cropping raises the question of the economic value of this great and increasing quant-

ity of provender and the best means of turning it into marketable form by feeding it to live stock. Since the screening and bran and shorts grown annually in this state would fatten all of the live stock grown on our vast ranges a study of the most economic use of these products in feeding live stock is of vast importance. More or less of unmarketable and cheap grain is produced each year which is wasted if not consumed by farm animals and which will add another source of income if means for its economic use can be divised.

A machine shed and Farm Mechanics class room are much needed equipment, which I estimate could be constructed for the sum of five thousand dollars ($5,000.00) and I would recommend that the expenditure be made for that purpose. The manufacturers of improved farm machinery have been very liberal in the matter of donating machines, models and sections of machines for experiment and class room work in so much that the institution has been unable to house some of the more expensive types of machinery thus loaned and donated. The room now used for the Farm Machanics classes is ill adapted for the purpose, too small and it is badly needed for Agronomy class work.

In view of the facts cited above it would seem to be short-sighted policy not to provide for the storage of donated implement and for the class room work with farm machinery.

This Department is crowded for class room and laboratory space, but as I believe that you plan to assign it space to be freed by the provision to be made for the woman's work of the institution, it will require no special outlay of funds.

The specimens in the Agricultural Museum are being spoiled through a lack of suitable cases in which to mount them for display and I recommend that the sum of five hundred dollars ($500.00) be expended for the construction of cases suited for that purpose.

My thanks are due and hereby tendered to the following young men who have assisted me in carrying the work during the past year for which this Department has been held responsible: Assistant O. O. Churchill has carried large responsibility in the plant breeding nursery and field crop work now under trial; Assistant W. B. Richards has taken the responsibility for the detail of the animal husbandary work; Assistant J. C. McDowell has made most of the studies in soil moisture that the Department has been able to carry; Student Assistant Oliver Dynes has given much aid in the poultry trials which have been undertaken and has rendered efficient service; Mr. E. G. Schollander has carried the work of the demonstration farms with little of counciling since their location was decided upon and the plan of rotation arranged. His

work throughout the season has been commendable; Mr. C. M. Hennis has carried out the detail of the work required of the farm foreman in an efficient, conscientious manner and relieved the writer of much detail of the farm work and management.

Respectfully submitted,

J. H. SHEPPERD,
Agriculturist.

HORTICULTURAL DEPARTMENT

To Director J. H. Worst,

Sir:—The outline of work carried out by the Department of Horticulture and Forestry is as follows:

Tree Planting: A plot comprising twenty-four acres was laid out in separate acre plots on which to plant trees for experimental purposes. The different points to be determined are the growth and hardiness of different varieties, the comparative value of different varieties for different purposes, and finally the best methods of culture including distance apart in planting, time and manner of pruning, thinning, etc. The work outlined contemplates the planting of six acres each year. In 1906 four acres were planted including the arbor-vitæ, Scotch pine, white spruce, European larch, jack pine and white poplar.

The evergreen seedlings sent by the Division of Forestry were small in size and though the season was favorable the number that came through the first season alive was not large. Six acres additional will be planted in the spring of 1907, and the dead plants will be replaced.

Other forest trees to the number of a thousand were planted for windbreak and shade.

Of the trees planted in 1905 the Russian olive made a very uniform and satisfactory growth indicating its value in the Northwest for windbreak and hedges.

Catalpas and black walnuts came through the winter with very slight injury.

Fruit Trees: Five hundred apple seedlings grown from selected seed were planted as the basis for a seedling orchard. If any reasonably promising varieties develop they will be used as a basis for breeding. The others will be utilized for student work in top grafting.

A number of plum trees and small fruits were set out including one and one-half acres of strawberries.

The third generation of selected seeding plums produced fruit in some quantity. A few of these trees show about all of the good of the best cultivated sorts of American plums.

The winter of 1905-06 was unusually trying to most fruit trees. While but few were killed outright all were injured to some extent, many of them severely. The young wood of many of the apple trees was badly injured so that they required cutting

back to the trunk. Others were partially cut back. In all of the trees the time of leaving out in the spring was much delayed. The injury was no doubt principally due to the excessively wet season of 1905.

Aside from the selection and breeding of promising strains of sweet corn and tomatoes the vegetable garden is devoted chiefly to a test of varieties and a demonstration of the best methods of culture.

A rather extended variety test of celery has shown so far that none of the English or French varieties are equal in quality to the leading American sorts like the Winter Queen and Evans Triumph. None of the imported self-blanching kinds are equal in quality nor so commercially profitable as the White Plume that has been carefully selected to eliminate pithiness. There is still considerable room for improvement in celery generally, and with proper facilities we hope to take up the work next season.

INJURIOUS INSECTS: The damage from insects was less than in most recent years. The Hessian fly was so attacked by parasites in 1905 that it was found in destructive numbers in but a few places in 1906. No other injurious insect appeared in sufficient numbers to cause any alarm. The few reports of injury from cut worms showed that pest to have been greatly reduced in numbers since the previous year.

Of the garden insects the cabbage-worm was the only one that caused general complaint. This insect has increased very rapidly and in many places has become very troublesome. The increase in the cultivation of rape for feeding purposes may account in part for this. It can be largely controlled in a cabbage patch through spraying with Paris green, but it is difficult to see just what measures can be used to destroy it in a field of rape and still leave the plants fit for pasturing. This insect does not appear to be periodically swept off by disease and parasites as are the cutworms and Hessian fly.

C. B. WALDRON.

Department of Veterinary Science

President J. H. Worst,
Agricultural College, N. D.

Sir: The following is a report on the research work done by this department during the year ending January 31, 1907.

"SWAMP FEVER" IN HORSES.

Without aiming to give here a detailed description of the disease more commonly known as "swamp-fever," it may be advisable to explain, that for several years past, there has occurred in the Dakotas, Minnesota and Manitoba and in various other localities, an anæmia among horses, which because it often is found in low localities and because it usually is accompanied by fever, is spoken of as "swamp fever."

The greatest losses from this disease appear to have occurred in Manitoba and Minnesota ,while the losses in North Dakota were thus far considered to be rather slight. Evidence has come to light, within the last year, that many farmers in the Red River Valley have suffered losses on account of a horse disease, which, while it may not be identical, with the Manitoba disease, certainly shows a great clinical resemblance to it. One farmer living within twelve miles of Fargo, N. D., estimates his losses from this disease for the last four years at $3,000.00.

With a view of securing information on this disease and especially with a view of ascertaining whether or not this "swamp fever" is a specific disease or a term loosely applied to any chronic anæmia, this Department has been active in gathering data on this important subject.

While a great amount of material will have to be worked over to obtain some definite result, and while it would be presumptuous to draw final conclusions from the work done, sufficient advance has been made to warrant the following of a certain thread of research in the cases and material which the future may bring within our reach.

The details of the work done are as follows:

No. 318

HISTORY AND CLINICAL ASPECTS.

This case was obtained from the Lake-Park region in Minne-

sota where it had been diagnosed as "swamp fever" by a local veterinarian. The mare, about seven years old, when first seen was in a fair state of nutrition. She showed to be anæmic, by the pallor of the conjunctiva and the vaginal mucosa and by the swaying motion of the hind quarters, exhibited a marked degree of weakness in those parts. This feature, however, was not constant, and at one time there could be nothing observed indicative of this weakness.

Fever was a constant feature during the 147 days during which she was under observation. For the amount and character of the fever, the reader is referred to the clinical chart hereby appended.

The pulse was marked by its small volume, in fact on several occasion, it could not be felt, hence the gaps in the pulse curve on the chart.

Appetite was always present, except towards the last when it became somewhat capricious.

Other clinical data are indicated on the chart.

It may be well, however, to mention that in making the blood counts, great difficulty was encountered in obtaining an even distribution of the corpuscles through the diluting fluid, as there seemed always to be present a marked tendency on the part of the erythrocytes to agglutinate, no matter how quickly the blood was mixed or what diluting fluid was selected. In order to avoid errors in the counting, two pipettes were used and from each several drops were used in the counting chamber, but in spite of this, it is probable, that the figures obtained are not quite correct.

The differential leucocyte counts gave the following results:

Date	10-28-05	11-4-05	11-11-05	11-17-05	12-23-05
Lymphocytes	19.0%	18.5%	15.5%	17.0%	14.5%
Neutrophiles	76.5%	77.0%	75.0%	71.0%	73.0%
Eosinophiles	3.5%	4.5%	9.0%	11.0%	11.0%
Basophiles	1.0%	0.0%	0.5%	.1%	1.5%

The microscopic examination of a great number of blood smears does not disclose any marked changes in the red corpuscles. At certain times quite a number of poikilocytes were to be seen and at others crenation was present. At no time could nucleated red cells be found.

The search for parasites in the blood constantly yielded negative results.

AUTOPSY.

The carcass is in an emaciated condition. Upon the removal of the skin, a uniform light yellow discoloration of the subcutaneous tissue is noticed, while in certain areas, edema is present.

The *Peritoneum* is of a dirty yellow color. Its surface is dull and the portion which covers the diaphragm and the anterior surface of the liver is thickened and covered by a fibrinous exudate.

The *Intestinal Canal*, the *Pancreas*, the *Genital Organs*, and *Urinary Bladder*, are normal. The small intestines contain a yellow mucous or bile, while the contents of the large intestines are soft, mushy, and a search for parasites had a negative result.

Many of the *Mesenteric Lymphnodes* are enlarged some, are engorged with blood, others are merely hyperplastic.

Sections of the engorged nodes show great dilation of the capillaries and hemorrhages into the adenoid tissue. Pigment deposits are well marked, while the connective tissue does not seem to have undergone marked changes. In a few sections, however, hyaline degeneration is noticed.

Smears, made from one of the congested mesenteric lymphnodes, reveals numerous erythrocytes and a few lymphocytes, between which a small coccus may be noticed in considerable numbers. In smears from another node no micro-organisms could be seen and besides red blood cells and lymphocytes, there were present neutrophiles and quite a considerable number of eosinophiles.

The *Spleen* is enlarged and rather pale in color. Sections show that the trabeculæ are thickened and while the cellular elements do not appear to be dimished, a sclerotic tendency seems to be present in those, which show the greatest amount of thickening.

The spleen pulp shows no change from the normal. The Malpighian bodies are not sharply defined and in some instances show a slight thickening of their reticulated connective tissue framework.

Throughout all the elements composing the organ, there is a liberal sprinkling of hæmosiderin granules.

The arterial walls are rather thick. In smears made from the cut surface a few short bacilli are seen.

The *Liver* is enlarged, with a weight of 8.5 K. G. Its color has a light yellowish cast. The capsule is thickened and contains from 20-30 dense, calcareous nodules from 1-1.5 C. M. in diameter and somewhat projecting from the surface. The liver surface is smooth and there is no apparent distortion or change of the organ, besides the ones mentioned.

On cutting through the gland, an increased density of the organ is noticed, but it does not give rise to the grating of the knife experienced when cutting through cirrhotic livers.

Stained sections from this organ show a well marked interstitial inflammation to be the most prominent lesion. In the interstitial connective tissue throughout the organ infiltration of small round cells has taken place, while in many sections connective tissue proliferation can be observed.

A moderate degree of hæmosiderosis is present, the pigment granules, usually of considerable size, being for the greater part confined to the hyperplastic interstitium although some smaller ones are scattered throughout the parenchyma.

The thickening of the interstitium on the whole, has not reached such a development as would warrant the term cirrhosis, but several sections show that there is a tendency in that direction.

The round cell infiltration is not confined to the interstitium, as in many sections small round cells can be seen between the liver cells within the lobules. This is especially the case near the periphery of the lobule and is most marked in the immediate vicinity of the areas where the interstitial changes are most advanced. A slight degree of intravascular connective tissue proliferation is also noticed within the lobules.

The changes in the parenchyma are not well marked. The hepatic cells are finely granular and have an ill defined contour. In some areas they are slightly atrophic, but as a whole, the parenchymatous lesions are slighter than they usually are in cases, where the interstitial lesions are so well marked.

Of the bloodvessels, the hepatic artery shows a slight degree of sclerosis with a moderate thickening of the media. The interlobular veins are somewhat dilated and in some places plugged with a finely granular thrombus containing leucocytes and pigment granules or with a debris, the nature of which could not be ascertained.

The intralobular veins show no marked changes, while the same can be said of the bile ducts.

In a few of the sections examined there occurred small areas ($\frac{1}{4}$ m. m.) composed of debris and enclosed in a fibrous connective tissue capsule. They have the appearance of small abscesses, of which the contents underwent desintergration and absorption.

In some other sections small nodules were detected, composed of a dense mass of small round cells in which are contained from 3-5 foci, either showing a somewhat concentric arrangement of structure or an ill defined granular mass. The degree of desintegration, however, did not permit a further identification of their component parts. They may be of a parasitic nature or they may be old miliary abscesses.

The nodules on the liver surface are of a parasitic origin. They are almost entirely composed of a dense connective tissue and contain the remains of the parasite, in which considerable calcareous infiltration has taken place. The coils of the worm can be readily seen with the naked eye. The nodules project somewhat from the surface, although they extend much deeper into the liver tissue. Their free surface is covered by a greatly thickened Glisson's cap-

sule, while in their immediate vicinity the liver cells are markedly atrophic.

Some smears made from the cut surface of this organ, reveal the presence of a considerable number of micro-organisms a short bacillus with rounded ends and a small coccus predominating.

The *Kidneys* are paler than normal, but otherwise present no macroscopic lesions.

The microscopic lesions are extremely slight, and altogether out of proporton to what might reasonably be expected in a case, which was sick for such a long period.

The lesions consist of a slight thickening of Bowman's capsule in some of the renal bodies, while in others the glomerulus fills the capsule entirely. The epithelium of the tubules is intact in all sections examined.

The only evidence of interstitial involvement consists in a few round cells aggregated about some of the renal bodies.

Throughout the organ there occur slight deposits of blood pigment, but they are more particularly seen in the medullary portion.

The arteries show the only lesion which attracts attention upon a superficial examination. The walls are greatly thickened, both the media and the externa being involved. The thickening is not sclerotic in nature, but rather hypertrophic and in many instances the lumen of the vessel is nearly obliterated.

The *Lungs* are normal, but on the inner side of the left lung pleuretic adhesions are present.

The *Pleura* of the right lung contains a small, dense, fibrous nodule of parasitic origin, sections of which present small abscesses, surrounded by a thick capsule and loops of the worm embryo, as it lies coiled up in the surrounding tissues.

The *Pericardium* contains about 200 c. c. of a yellow watery fluid.

The *Heart* is of a pale color and immediately under the endocardium of the right auricle some hemorrhagic spots are present.

No. 403.

HISTORY AND CLINICAL FEATURES.

In this case that of a four year old colt, the disease first manifested itself some nine weeks before the animal was destroyed. At first nothing but a marked degree of dullness was noticed. Soon after, when at work the colt showed soreness in moving about. Later the animal gave evidence of great pain and remained in the recumbent position most of the time. The suffering gradually subsided, leaving the patient in a very weak condtion. Some cerebral

disturbance, the exact nature of which could not be learned had been present and a short time before the animal was seen it had become blind in both eyes, apparently by an inflammatory condition of the uveal tract.

When the animal was seen, it was emaciated, showed an unsteady, wobbly gait, a normal respiration, a rapid small pulse, a temperature of 101½ degrees F., while the appetite was good.

AUTOPSY.

This animal was killed by bleeding from the carotid artery. During the removal of the skin it was noticed that the subcutaneous connective tissue presented a decided yellow color.

Upon opening the abdominal cavity the *Peritoneum* was found to be covered by a fibrinous exudate and also showed considerable thickening in certain places.

The apex of the *Caecum* was bound to the abdominal wall by a thick, dense and very strong adhesion, which was difficult to break loose. The walls of the *Large Intestines* contained a few parasitic nodules, while some small worms (Sclerostomum) were found among the intestinal contents. In one area, about the size of a man's hand, the wall of the intestine is thickened, hemorrhagic and edematous.

Histologic preparations show this thickening to be confined to the peritoneal covering of the gut. This is the seat of considerable round cell infiltration, while a few small hemorrhages are observed. The intercellular spaces are filled with a serous exudate and within the inflamed tissues, several specimens of a small round worm (Sclerostomum) are found.

The *Spleen* is uniformly enlarged. The trabecular frame work shows no changes. The pulp is very rich in lymphocytes, among which there are a great number of erythrocytes, which in the doubly stained section (hemotoxylin and eosine) cause the pink color to dominate in many places.

The Malpighian bodies appear to be normal. Many of them are surrounded by a zone in which the red blood cells are exceedingly numerous.

Hemosiderosis is present to a considerable extent.

The *Liver* is slightly enlarged, but otherwise no gross lesions are apparent. The organ is slightly resistant upon section. All histologic preparations made from this liver show a diffused round cell infiltration and connective tissue proliferation. This pertains both to the interstitium and to the lobules.

The thickening of the former is moderate in degree, but the accumulation of round cells is a well marked feature throughout the organ. Within the lobules the round cell agglomeration is es-

pecially noted in connection with the intralobular capillaries, which present themselves as radiating streaks when the stained preparation is examined with a low power objective. The location of those cells is both intra and perivascular and in many places the bars of liver cells are notably damaged by the encroachment of the numerous round cells. A moderate intravascular connective tissue proliferation is shown by the vessels of the lobules.

Degeneration of the parenchyma is marked. Cloudy swelling is the predominating type. In groups of hepatic cells small yellow hemosiderin granules are present, while larger masses of the same substance are scattered throughout the sections. Hemosiderosis, however, is not a very marked feature in this liver.

The arteries are moderately thickened, while the veins appear to be somewhat dilated. In a few sections a slight hyaline degeneration of the walls of the central veins can be observed. Those changes have the appearance of amyloid, but as no special analysis was made, this is only a matter of opinion.

The bile ducts appear to be slighty thickened, while their epithelium shows a certain degree of proliferation. Those changes, however, are so slight, that they can scarcely be considered as a distinct lesion.

The macroscopic appearance of the *Kidneys* was normal.

The microscope reveals that most of the renal bodies are normal. There are some which seem to have their capsule closely contracted upon the glomerulus, but their number is very small. In no section, however, did the glomerulus show degenerative changes.

The epithelium of the tubules shows degenerative changes. Those changes are in the nature of cloudy swelling and fatty degeneration, but are slight in extent. Some of the tubules contain a debris, consisting of a granular substance in which fat droplets and fatty, exfoliated epethelial cells are contained.

Many of the blood capillaries throughout the organ are distended with blood corpuscles and at the places where this phenomenon is the most pronounced, slight interstitial lesions can be seen. They consist of small agglomerations of round cells, which are often accompanied by a connective tissue proliferation. In a few sections very small hemorrhages have taken place and red cells may be seen between the constituent parts of the parenchyma. The bloodvessels show no marked alteration.

The *Pleura, Heart, Lungs,* and *Lymphnodes* are normal in appearance.

Upon opening the spinal canal about 30 c. c. of a bright yellow fluid escaped, but *Brain, Cord* and *Meninges* presented no apparent lesions.

Fig. 1. MESENTERY, SHOWING FIBRINOUS EXUDATE.

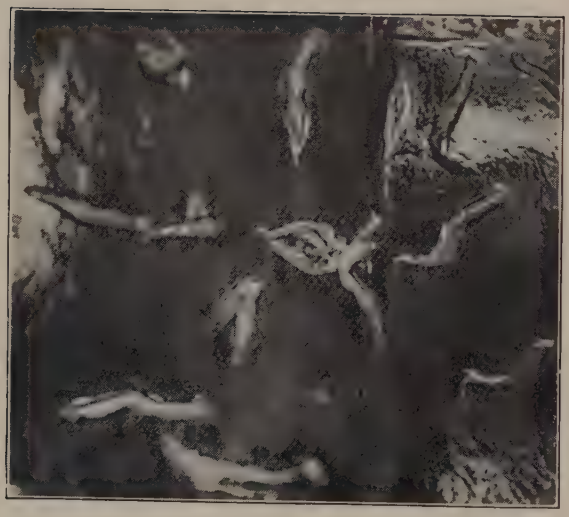


Fig. 2. FIBRINOUS EXUDATE ON SURFACE OF LIVER.

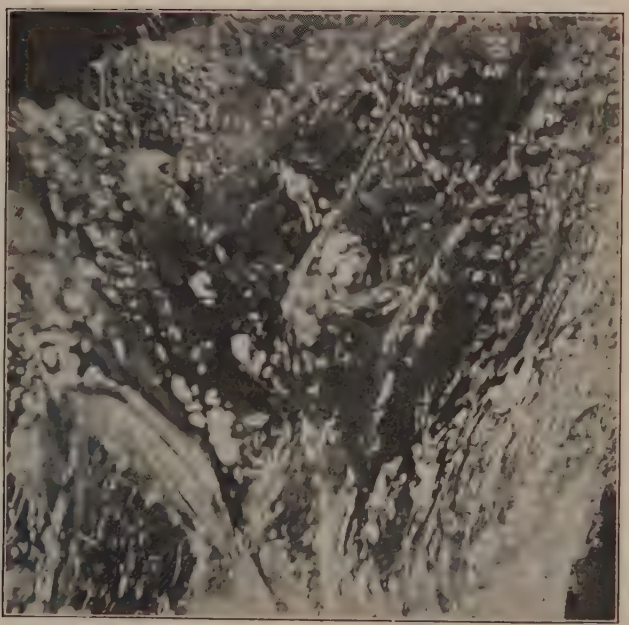


Fig. 3. HEMORRHAGIC AREA UNDER SEROUS SURFACE OF LARGE INTESTINE.

Fig. 4. HEMORRHAGIC SPOTS ON MUCOSA OF LARGE INTESTINE.

The examination of the eyes revealed an acute inflamatory condition of the uveal tract; a search for parasites in those organs had negative results.

No. 410

HISTORY AND CLINICAL FEATURES.

This case, a four year old colt, was of a comparatively recent origin, at the time it was placed under our observation. The mucosæ were very pale, the gait swaying, while the appetite was somewhat irregular. The pulse was small and after the animal had been under observation for a few days, the bowles became constipated, although at no time was any evidence of pain present.

For further data see clinical chart.

AUTOPSY.

The carcass is in a very marked emaciated condition. After removal of the skin, the absence of adipose attracted attention. All tissues exposed were extremely pale. In the pectoral region a large subcutaneous hemorrahagic spot is observed and a smaller one is seen over the levator humeri muscle.

The sheath and the lower portions of the abdominal and thoracic wall are edematous.

After opening the abdominal cavity, a generalized fibrinous peritonitis was revealed. The fibrinous exudate occurs either as fine threads on the parieties or mesentery or as course, short bands on the surface of the liver, spleen, and on some parts of the intestines. (Figures 1 and 2.)

One of the *Mesenteric Lymphnodes* was found to be considerably enlarged. Upon incision, it proved to contain a quantity of pus and in this pus one small round worm was found (Sclerostomum.)

At one point the *Large Colon* presents a hemorrhagic infiltration of considerable extent. In the center of this area and covered by a thin layer of peritoneum is another round worm, but of a much larger size than the one spoken of in the preceding paragraph. The thin serous layer presents three or four small openings, which communicate with the general peritoneal cavity. (Figure 3.)

The mesentery of the *Small Intestine* shows fibrinous peritonitis throughout, while the omentum is marked by a large hemorrhagic spot.

In the contents of the large intestines a large number of small nematodes is found. The mucosa of caecum and colon shows a great number of hemorrhagic areas. (Figure 4.)

The *Spleen* is enlarged (1.485 K. G.) and covered by a fibrinous exudate. Microscopic examination shows this organ to be greatly congested as the pulp is permeated throughout with red blood cells. Hemosiderosis is also very pronounced. Otherwise no marked lesions can be found.

The *Liver* is congested, but otherwise shows no gross leisons, which would attract attention.

Sections from this liver reveal interstitial inflammation as the predominating lesion. Throughout the entire organ the interstitium is infiltrated by round cells, which are also thinly scattered about within the lobules. In that location they are not confined to the intralobular capillaries, but are diffusedly disseminated among the cells of the parenchyma.

A marked connective tissue proliferation can not be shown in any of the sections; although connective tissue elements are by no means lacking.

The gland parenchyma shows degenerative changes, both albuminous and fatty. The cells appear enlarged and their outline is ill-defined. In quite a number the nucleus has broken down. Owing to the changes mentioned, the hepatic trabeculæ are poorly marked, so that in many places, the characteristic picture of liver sections is almost completely lost.

Hemosiderosis is present in all sections, while in a few places small hemorrhagic areas can be seen.

Of the bloodvessels, the arteries have a normal appearance, while the interlobular veins are somewhat dilated. The bile ducts are normal. In a few sections there are seen, small masses of leucocytes, contained in a granular debris and enclosed in a rather thin fibrous capsule, which in quite a number of instances shows hyaline changes.

The *Vena Cava Posterior* contains a large thrombus which fills the greater part of the vessel's lumen.

The *Anterior Mesenteric Artery* shortly after it leaves the aorta is thickened and bound down by a dense fibrous connective tissue. A thick fibrinous mass adheres to the intima and contains some small round worms (Sclerostomum armatum?.)

The *Kidneys*, aside from an apparent condition of congestion, present no appreciable gross lesions.

As a whole the renal bodies are intact. The same may be said of the epithelium of the tubules, although here and there evidence of degeneration is present. In some of the tubules notably those forming Henle's loop, the lumen contains a finely granular substance and some broken down cells.

Interstitial lesions are also present. They are confined to small areas immediately surrounding the renal body and to other

small areas occurring independently in the cortex. Most the interstitial changes are of a circumscribed nature and consist wholly of round cell infiltration. At no place could connective tissue proliferation be detected. In a few sections, capillary distension was seen, but not to a very marked degree. The walls of the arteries are thickened.

The *Lungs* are somewhat emphysematous. The *Epicardium* shows a few petechia, while the *Heart Muscle* has a par-boiled appearance. Sections made from the heart, however, do not show a marked degeneration. The stria of the fibers are poorly defined and a few granules show in the protoplasm, but otherwise nothing abnormal can be seen.

No. 420.

HISTORY AND CLINICAL FEATURES.

This seven year old mare had been sick for over two months. She had shown weakness, staggering, swaying gait, a marked emaciation, while the appetite remained normal until the very last. At one time, she appeared to be improving, but soon went from bad to worse and finally died. Other clinical data could not be obtained.

AUTOPSY.

The carcass is very much emaciated. The *Conjuctival Mucosa* is pale with a yellow tinge, while that of the *Vagina* is lemon colored.

No marked lesions are encountered during the autopsy, but in the *Caecum* and *Large Colon*, enormous numbers of round worms (Sclerostomum) are present. No nodules in the intestinal walls can be detected and a careful examination of the mesenteric arteries does not reveal any parasitic lesions.

The *Liver* is congested, non-resistant to the knife, while the apex of the right lobe is atrophic.

After the blocks of tissue, intended for histologic study were fixed in formaldehyde solution, they showed the characteristic features of "nutmeg liver."

Both interstitial and parenchymatous changes are exceedingly well marked in this liver.

Round cell infiltration is the predominating feature of the interstitial lesions, although the connective tissue proliferation has reached quite a stage of development.

Round cells are also found among the hepatic trabeculae of the lobule, while the intralobular capillaries also show evidence of connective tissue proliferation.

The most striking feature of the microscopic field is that produced by the areas of congestion and parenchymatous degeneration immediately around the central vein of the lobule. Here the capillaries are greatly dilated by erythrocytes, while the picture thus produced is further intensified by a considerable deposit of large granules of hæmosiderin, which is entirely confined to those perivascular areas within the lobule. In the areas spoken of the cells of the parenchyma are for the greater part eliminated by granular and fatty changes. The parenchyma outside the zone of congestion also shows a slight degree of cloudy swelling, but as a whole is in a fairly intact condition.

The walls of the arteries show no deviation from normal conditions, but many of the arterioles are plugged by masses of deeply stained leucocytes.

The veins are dilated and those of the center of the lobule present hyaline (amyloid?) changes in their walls.

The bile ducts are normal, but there seems to be a tendency for the leucocyte infiltration to be the densest in the zone immediately surrounding the excretory ducts.

Sections made from the atrophic apex of the right lobe, show a complete disappearance of gland-parenchyma, while the structure is made up of greatly thickened bloodvessels and bile ducts contained in a connective tissue stroma, composed of cellular elements and intracellular fibrous tissue with a liberal sprinkling of leucocytes.

The *Spleen* is about normal in size. Its capsule is rather thick and upon section some resistance to the knife is encountered. The cut surface has a brownish tint and shows the trabeculæ quite prominently.

The examination of histologic preparations shows, that the trabeculæ are increased in width and sclerotic. Cellular elements are seen only in a few places. The sclerotic trabeculæ do not contain pigmentary deposits. The pulp contains marked hemosiderin deposits and in places is infiltrated by red cells. Malpighian bodies are not seen.

Both *Kidneys* are of a yellowish pale color and perhaps slightly enlarged.

Microscopically, both parenchymatous and interstitial lesions are recognized. The former consists of atrophy of a considerable number of the glomeruli. The atrophic glomeruli are smaller than normal, show in many instances distortion by having become elongated and flattened and are frequently contained in a thickened, sclerotic capsule. In some, those changes are more advanced than in others, while in those that have suffered the greatest change a small round cell invasion may be observed. A few apparently nor-

mal glomeruli are seen contained in a thickened Bowman's capsule.

The changes in the tubules seem to occur in more or less circumscribed areas and consist of a granular deterioration of the epithelium, while the evidence of fatty degeneration is not lacking. In a number of tubules composing the loop of Henle, hyaline casts may be seen in situ.

In the interstitium, periglomerular, as well as intertubular round cell infiltration may be observed. In many sections, those lesions are pronounced and extend over a considerable area.

Interstitial connective tissue proliferation is observed in a few instances and is frequently associated with the parenchymatous lesions described above.

The arteries are thickened and in quite a few cases have their lumen diminished.

No. 421.

HISTORY AND CLINICAL FEATURES.

This 28 year old gelding had, until the morning of his death been in apparent good health. At the time mentioned he was taken with a sudden colic of unusual severity and which rapidly proved fatal.

While the case, according to the owner never showed any sign of "swamp fever" it was deemed wise to make a post-mortem examination as the disease had caused considerable losses among the horses on the farm; where the gelding was owned.

AUTOPSY.

The post-mortem examination, which was made two hours after death, revealed the fact that the abdomen was enormously distended with gas.

The *Large Intestines* contained enormous numbers of round worms (Sclerostumum) while a few small parasitic nodules were present in the mucosa. The peritoneum throughout was covered by a fibrinous exudate.

The *Spleen* is slightly enlarged, but otherwise shows no macroscopic lesions.

Stained sections show the trabeculæ to be of normal size, somewhat sclerotic and here and there marked by hyaline changes.

The pulp is dense and thickly sprinkled with pigment granules. Distinct Malpighian bodies are not seen.

The arterial walls are slightly thickened, while in many places veins are seen to be greatly distended with blood.

The *Liver* is somewhat congested but otherwise does not show any gross lesions.

The examination of histologic sections shows the presence of a moderate degree of interstitial lesions in which connective tissue proliferation, however, is a more marked feature than round cell infiltration. The thickening of the interstitium is slight and has not reached the stage in which the periphery of the lobules becomes sharply defined in the microscopic field.

Within the lobules, the round cell infiltration is more marked, the cells being diffusely distributed throughout the lobule, although in a few instances they are concentrated around the central vein, where they show a tendency to cluster about the capillaries.

Some evidence of parenchymatous degeneration is present, but the organ does not seem to be seriously impaired by those changes. Some cells show poorly stained nuclei and a granular protoplasm, while other cells adjoining those are in a fairly intact condition.

Hemosiderosis is present to a considerable extent, the granules being most numerous and largest where the round cell infiltration is most marked.

The arterial walls are slightly thickened. Both the inter and intralobular veins are somewhat dilated. The walls of the latter are thicker than usual and in a few lobules show hyaline changes. The bile ducts appear to be normal.

Darkness prevented the observation of the gross lesions of the *Kidneys,* if any were present.

Sections suitably prepared for histologic examination, show some marked lesions. The Malpighian body often presents an atrophic, distorted or shrunken glomerulus, which may or may not be accompanied by the thickening of Bowman's capsule.

The tubular epithelium has a granular protoplasm and although the stain affinity of the nuclei is not lost, they are by no means marked by a good coloration. In some instances, the tubular epithelium has retracted from its membrana propria. This is especially seen in the case of the descending limb of Henle's loop. Casts are seen here and there.

The interstitial changes consist of small circumscribed areas of small round cell infiltration and of a diffuse thickening of the connective tissue elements of the organs. This, in place, is slight, so that at first, the condition may be overlooked, while in others it approaches the features of cirrhosis.

In numerous small areas, both in cortex and medulla, capillaries distended with red cells may be observed, while in many places slight deposits of hemosiderin are present. The arterial walls are slightly thickened.

The *Thoracic Organs* were greatly compressed. The *Pleura* showed a fibrinous exudate, similar to that of the peritoneum, while the *Pericardial*, sack was distended by a large blood clot.

The *Heart* revealed the evident direct cause of death as the right auricle was ruptured, presenting a tear about 10 c. m. in length.

No. 442.

HISTORY AND CLINICAL FEATURES.

This case suffering from a profound case of anæmia and general weakness was given to the experiment station for the purpose of study and investigation.

At the time when the mare was first seen the disease has approximately lasted some four weeks although an indefinite history of a period of illness some five months previous could be elicited.

The mucosæ of the eyes and vagina were extremely pale, while the latter also presented a large hemorrhagic area. The gait is wobbly and staggering; the digestive functions and appetite are good.

As will also be seen from the clinical chart, the blood count shows a remarkably low number of red cells. When these results were first obtained it was suspected that an error had been made, but as subsequent counts yielded about the same results, it may be concluded that the number of red cells was certainly below 500,000 after making allowance for the possible errors which are apt to occur in the counting in cases of anæmia as profound as the one under consideration.

The macroscopic appearance of the blood is in accordance with the results of counting. The blood is thin and watery and through a pool of it which had escaped from the vein, the grain of the wood of the floor could be plainly seen. The blood coagulated with difficulty and while this was in progress the red cells settled to the bottom of the vessel in a very thin layer.

Stained blood smears showed a considerable degree of poikilocylosis, while there is a marked variation in the size of the red cells. The blood contains a very small number of nucleated red cells and a few myelocytes.

There was also observed some small bodies, usually occuring in groups of fifteen or twenty. They are from 1-3 microns in size and in shape are cresent, pyriform or hemispherical. They take a deep basic stain on one side, while the rest of the body is stained, but very feebly. These bodies were at first thought to be blood-platelets, but subsequent examination convinces me that they can not be regarded as such.

The differential leucocyte count gives the following results:

	12-15-'06	12-19-'06
Lymphocytes	57.5%	32.5%
Neutrophiles	40.5%	64.0%
Eosinophiles	0.0%	0.0%
Basophiles	0.5%	2.5%
Myelocytes	1.5%	1.0%

The urine has S. G. of 1015 and is faintly alkaline. Upon centrifugation a scant sediment is obtained, which shows the presence of a few granular tube casts and some epithelium. It contains a trace of albumen, considerable mucin, but neither sugar nor bile pigments.

The faces contained a number of small round worms. A number of them were collected and forwarded to the Division of Zoology of the United States Bureau of Animal Industry for identification. They were identified as follows: Oxyuris curvula, Cylichnostomum labratum, Cylichnostomum catinatum, Cylichnostomum tetracanthum, and the aid given in this matter by B. H. Ransom, Chief of Division, is hereby duly acknowledged.

AUTOPSY.

The carcass is thin, but not emaciated, the subcutaneous tissue along the lower surface of abdomen and thorax. The mucles are pale in color.

The *Spleen* is considerably enlarged and its posterior surface is marked by numerous small petechiæ. A large anæmic infarct is seen in the posterior portion.

Sections show that the trabeculæ are thickened and at places edematous, while the pulp offers no appreciable changes with the exception of a profuse pigment deposit uniformly distributed throughout the organ.

The *Liver* has a congested appearance and is quite large. Sections reveal a slight but marked degree of interstitial inflammation. The connective tissue elements have not proliferated, but round cell infiltration is the predominating feature.

In the parenchyma a profuse hemosiderin deposit is noticeable. The granules occur ether scattered diffusely or are sometimes seen to be packed into the liver cells.

The parenchyma cells in the immediate vicinity of the central vein show marked degenerative changes. Their nuclei are ill defined or broken down, while their protoplasm is granular or has undergone fatty changes. In some sections a certain degree of leucocyte infiltration has taken place within the lobule.

Blood vessels and bile ducts show no marked changes.

In the wall of the anterior portion of the *Duodenum* a hemorrhagic area was seen. In the large intestines a considerable number of small round worms were found.

Around the *Kidneys*, the tissues were hemorrhagically infiltrated, while the renal lymphnodes are considerably enlarged. The kidneys themselves are light in color and upon section the par-boiled appearance of the cortex is very marked while the medulla is pale-pinkish in color. The pelvis contains a muco-purulent fluid.

The histologic examination of the organs mentioned reveals the fact that they are very seriously impaired.

The glomeruli do not show marked changes. They closely fill out the available space in Bowman's capsule, while the capsule itself is thickened in many cases.

Parenchymatous changes are well marked and extensive. The epithelium of the convoluted tubules has almost completely degenerated. Nuclei are rarely met with and of the cell protoplasm there is nothing left but a granular debris. In the straight tubules, those changes are less marked, although in evidence. Tube casts are seen here and there.

The interstitial changes are fully as well marked as the parenchymatous ones. There is a diffused round cell infiltration and connective tissue proliferation all through the organ, which is most pronounced immediately around the renal bodies.

The bloodvessels show no changes. Sections from the renal lymphnodes show hyperplasia of the adenoid elements, some blood capillary engorgement and slight pigment deposits.

The *Pericardial Sack* contains about two liters of a clear light yellow fluid. The *Heart* is pale and the right auricle contains a large white clot. Sections from the heart reveal slight fatty changes and here and there broken down nuclei.

Cutting through the spongy bone tissue of the head of the humerous the same was found to be white—yellowish in color and quite fatty for the larger portion, while apparently normal bone marrow was present in a small portion occuring as red streaks on the outer surface.

Histologic sections of this material show that the red marrow has been largely replaced by the fatty yellow marrow. Marrow cells are absent from the fatty areas.

Bone marrow smears obtained by cutting through a rib, do not reveal any striking features.

Like in the blood the absence of eosinophiles is noted, while the fact that of the nucleated red cells a large number belong to the megalocyte type attracts attention.

No. 444.

HISTORY AND CLINICAL FEATURES.

This case came accompanied by a rather indefinite history of ill health of some six months standing.

When first seen the mucosæ were pale; the weakness of the hind quarters was marked although not as pronounced as in some of the other cases of this series. The appetite was good, although the animal was in poor flesh. The pulse although somewhat frequent was of normal volume and character. For other clinical data consult the clinical chart.

This case after remaining in the condition described above for some time gradually gained in weight, became stronger and was discharged in an apparent normal condition, with the exception of a slight raise in temperature.

Whether or not this apparent recovery is due to the use of the remedies mentioned in the chart can not be said. Up to the present time (three months after her discharge) she has remained in good health and condition.

BACTERIOLOGIC STUDIES.

Whenever the conditions under which the autopsies were held were suitable, the bacteria found in the different organs were studied, with a view of ascertaining if any species occur with any degree of regularity.

In the series included in this report only two autopsies were held under conditions warranting bacteriologic studies and the results are shown in the table hereby appended.

It is the aim of the Department to continue the study of this disease whenever the opportunity presents itself, in the hope of gathering a sufficient number of facts to warrant definite conclusion. The small number of cases, studied thus far, however, does not permit this, although the constant presence of certain features certainly can be used as a base for future research.

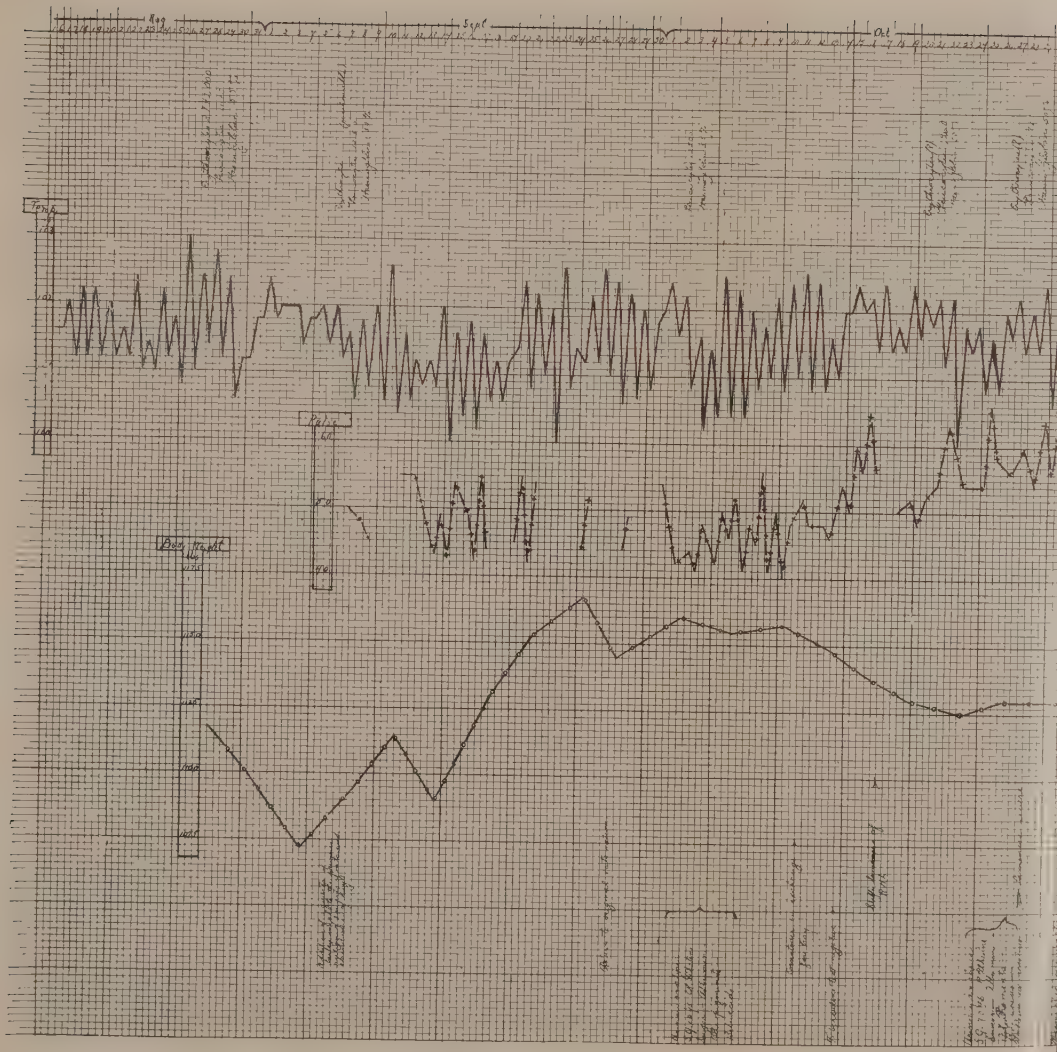
Respectfully submitted,

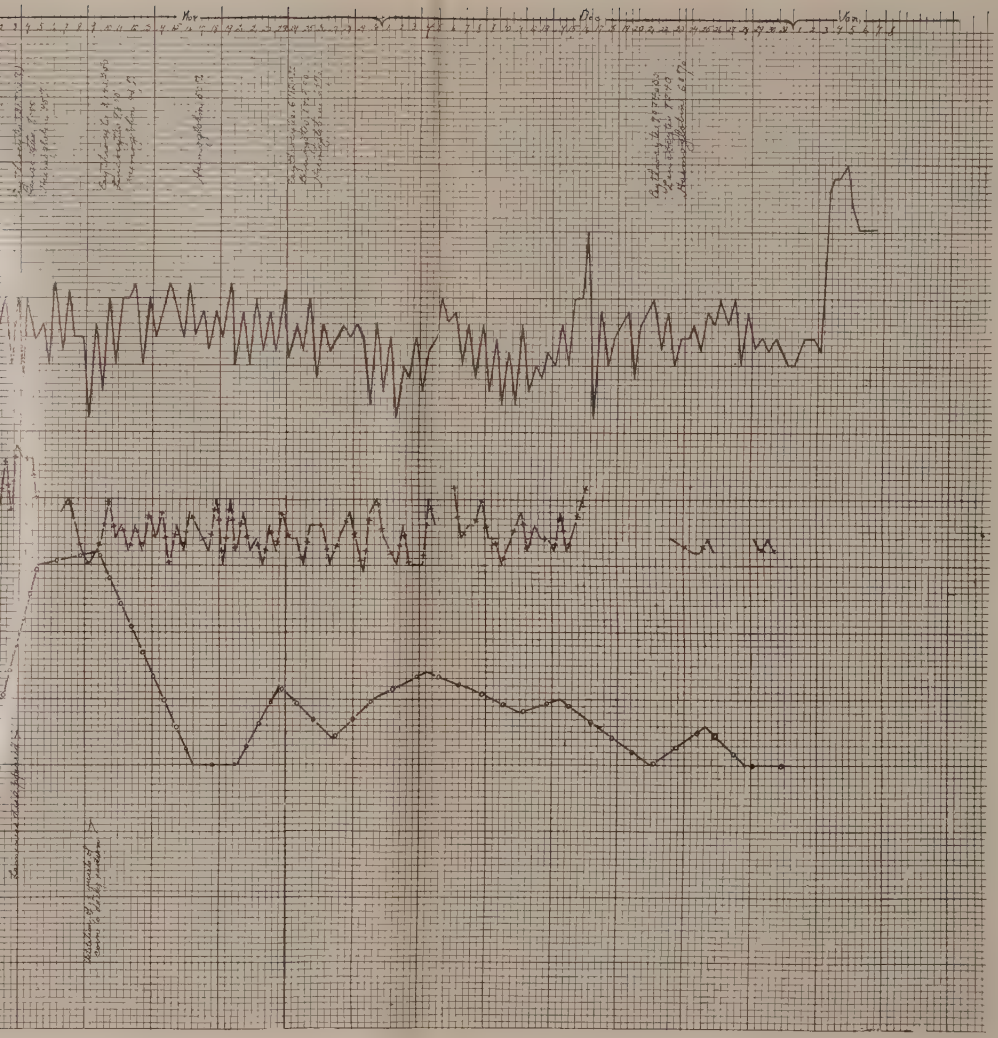
L. VAN ES.

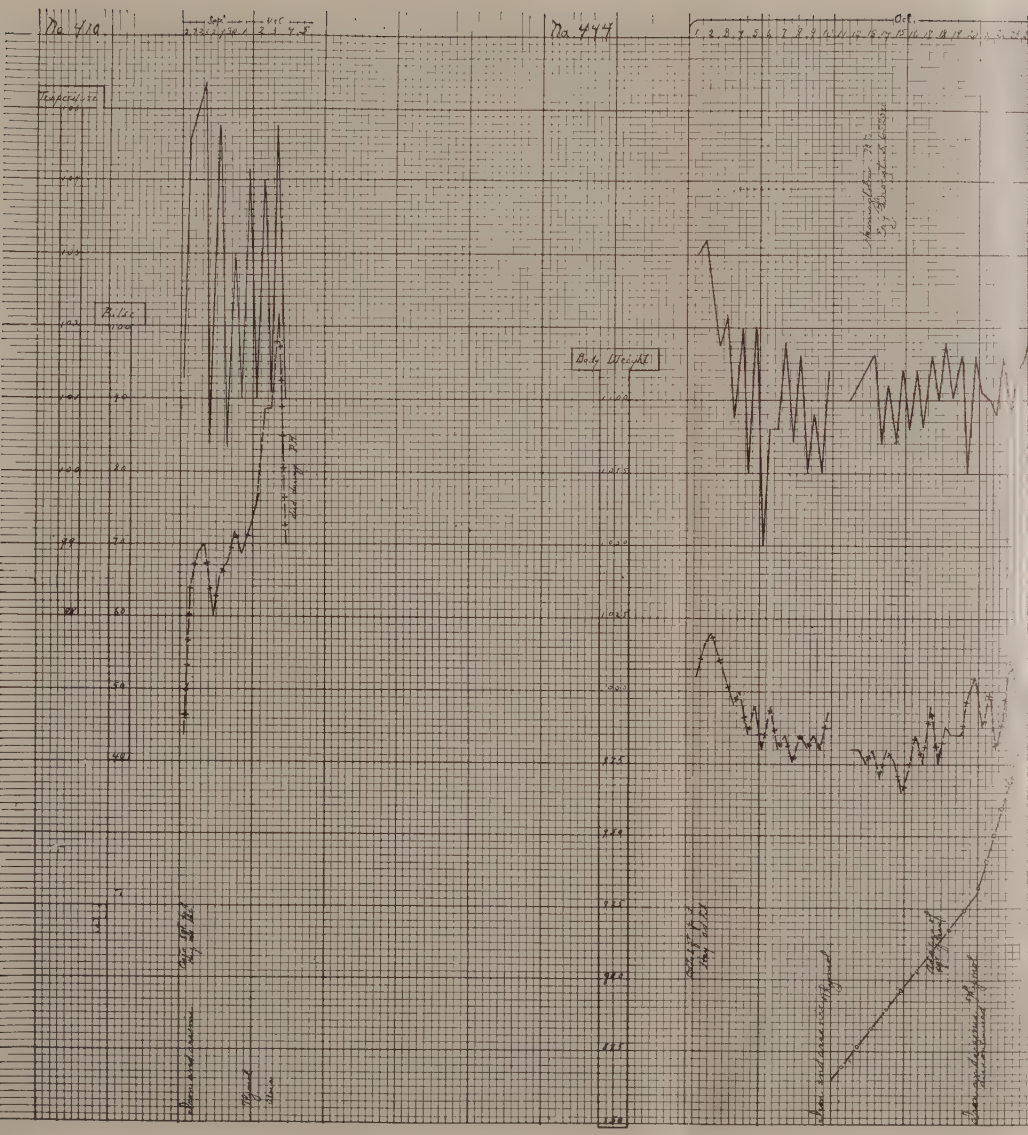
ADDENDUM.

This department is endebted to Mr. B. H. Ransom, Chief, Division of Zoology, U. S. Bureau of Animal Industry, for the identification of the parasites found in Nos. 410, 420 and 421.

No. 318






No 419
No. 444

Kor
Lage

No.	Organ.	Gelatine stab	Gas in gelatine tube	Agar Slant.	Blood-serum (horse)	Coagulation in milk	Bouillon.	Potato.	Agar plates	Gelatine plates	Morphology	Gram's stain	Remarks.
318 A.	Heart	Filiform No liquefaction	negative.	In 48 hrs a vigorous dry growth coating entire surface.	In 48 hours a luxuriant, dry, irregular, corrugated growth coloured & entire. Complete digestion in 7 days	coagulation	In 24 hrs there is a thick pellicle on the surface medium clear.	In 48 hrs a vigorous moist chocolate coloured growth with a tendency to throw out processes	Flat, filamentous.	Small white round or ovoid with filamentous edge	Long bacilli, isolated and motile also in chains spore former	positive	Non-pathogenic to guinea pigs.
318 F.	Heart	Slight Beaded No liquefaction	negative.	In 48 hours a slender white growth with isolated colonies.	In 48 hours a slender chain of isolated, creamy colonies	negative	In 48 hrs diffuse cloudiness slight, but medium. Stringy deposit	Slow growth in 5 days a white granular slightly raised cracked dry growth	Deep colonies round edges under about an inch surface colonies round, edges undulated	No growth secured	Non motile Cocci	positive	Non pathogenic to guinea pigs.
318 H.	Heart	Filiform. No liquefaction.	negative.	In 48 hours a moderate moist white. Translucent growth	In 48 hours an elevated thick. In 96 days partial liquefaction.	negative	In 48 hours a slimy growth with thick flocculent deposit	In 48 hours a vigorous glossy growth	Small round. Flat yellowish white slightly granular edges entire	No growth secured	Bacillus rounded ends motile	positive	Non pathogenic to guinea pigs.
318 J.	Heart	Filiform Very slight No liquefaction	negative.	In 48 hours a vigorous moist white elevated growth.	In 48 hours pearl thick of white colonies confluent in 96 hrs liquefaction in 21 days	negative	In 48 hours diffused cloudiness with slight deposit which after two days became very stringy	Grows well with slightly granular thin and moist	Round, colonies dusty white with raised centre and entire edges	No growth secured	Motile bacilli in long chains spore-former	positive	
318 K.	Mesenteric lymph node	Filiform No liquefaction.	negative.	In 24 hours a narrow. Translucent growth.	In 24 hours a moist elevated growth	positive	In 24 hrs diffuse cloudiness with flocculi In 48 hrs clear.	Moist moist creamy layer	Round yellowish brown convex granular with entire edges	Small round granular with entire edges	Very short motile bacilli	negative	Guinea pig no 1 died 18 weeks after inoculation loss of weight 108 g. Inflammation of peritoneum liver and spleen show few tuberculous nodules. Gland not examined Guinea pig no 2 died 5 weeks after inoculation loss of weight 107.5 g. Hyperaemia of lungs and right heart small quantity of fluid in peritoneum. Mesenteric glands and peritoneum negative results.
318 O.	Mesenteric lymph node	Slight Filiform Only in upper part of stab No liquefaction	negative.	In 24 hours a slender moist growth	In 48 hours a wide, moist, thin growth with serrated edges.	positive	In 24 hrs diffuse cloudiness no deposit in 48 hours	Thick creamy layer	Minute colonies small round or oval yellowish brown granular with entire edges	Small granular. Round edges entire	Small, non-motile Cocci	negative	Non pathogenic to guinea pigs
318 P.	Mesenteric lymph node	Filiform No liquefaction	negative.	In 24 hours entire surface covered with a thin layer.	In 24 hours, flat, crateriform growth and spreads all over. Fluid. Ppt. except in thin stab.	positive	In 24 hours diffused cloudiness no ppt. In 96 hours flocculent growth on surface	In 24 hours a thin layer. Late moist and corrugated	Small brownish guttrose with irregular edges	Small fluffy granular	Bacillus with rounded ends motile spore-former	negative	
318 R.	Liver.	Only in upper parts of stab Filiform no liquefaction	negative.	In 24 hours a vigorous growth [illegible] liquefaction in 6 days [illegible]	In 24 hours a vigorous growth [illegible] liquefaction in 6 days [illegible]	positive [coagulation very slow]	In 24 hrs a flocculent deposit; medium clear.	In 24 hours good vigorous yellow, raised & late muscular	Grumose, granular with irregular edges	Cotton granular surrounded by filamentous [illegible] edges	Undetermined, must further grow		
318 S.	Liver.	Grows on the surface of the gelatine. Scarcely liquefaction 30d	negative.		In 24 hours isolated, mostly colonies. In 48 hrs, confluent growth	negative	In 48 hours flocculent deposit. Cloudy: medium clear.	In 48 hours a vigorous moderate growth.	Filamentous	Filamentous	Undetermined, must further grow		Non-pathogenic to guinea pigs
318 U.	Pancreas	Filiform Only upper part of stab No liquefaction	negative.	In 72 hours a thin ground growth with serrated edges.	In 72 hours. a vigorous, moist granular growth	negative	In 48 hours diffused cloudiness	In 72 hours a very thin moist layer	Small, round, or elliptical, elevated, granular, thin edges entire	No growth secured	Thick motile bacillus with rounded ends spore former	positive	
318 W.	Pancreas	No visible growth	negative.	In 72 hours a narrow streak	Very slight	negative	In 72 hours isolated flocculi.	In 72 hours a scant moist growth	Round convex yellowish moist granular edges entire	Same as on agar	Motile. Spore forming bacillus	negative	
4128 A.	Pleura	Filiform No liquefaction	negative	In 72 hours a very thin growth covering entire surface	In 72 hours thin moist growth with slight liquefaction.	negative	In 72 hrs a thin cloudy growth with thready deposit	In 72 hours a moist thin layer	Round raised granular edges entire		Long slender motile bacilli	positive	Slightly acidity on litmus milk

The following are the parasites, identified by him:

No. 410.

Triodontophorus minor.
Strongylus edentatus.
Cylichnostomum radiatum.

No. 420.

Strongylus vulgaris.
Strongylus edentatus.

No. 421.

Strongylus vulgaris.
Cylichnostomum coronatum.

Great Northern Demonstration Farms

Director J. H. Worst.

Sir:—I herewith submit a report of the work mapped out, for a period of five years and the results obtained the first season, on the demonstration farms located at Ross, Granville, Lakota on the Great Northern main line; Beach, New Salem, and Bismarck on the Northern Pacific main line.

The land used for these experiments consists of five, four acre plats lying contiguously to each other on each farm. These plats were rented from the farmers, who had cropped the land different lengths of time, and with different crops. When the land was secured last spring, the season was well advanced, consequently most of the plowing was done. In several instances part of it was already seeded. This condition was a disadvantage because no data of the time, depth and condition of plowing, was taken. Part of the land had been plowed very poorly. Hence no astonishing results could be expected, nor would they have been of any particular value. However, the land received the best treatment possible under the existing conditions, after it was laid out for experimental purposes. The actual work of preparing the soil is done by the owners of the farms under my instructions, and I believe it is done very conscientiously by the farmers, though they are not accustomed to being very accurate in their field operations.

The object of these experiments is, to determine, what method of crop rotation is best adapted for that particular neighborhood, to introduce field corn and clover into the fields, to build up the fertility of the soil, instead of summer fallowing, and by extra tillage preserve the moisture and clean the land. The rotation at present is very limited in its scope. Alfalfa and brome grass should be introduced, and more different methods of rotation tried, but the present limited means would not allow this addition of work.

A rain guage and a maximum and minimum thermometer have been loaned us by the U. S. Weather Bureau for each of the farms except Bismarck. These, however, came too late to be of any value for this season's work, but hereafter an accurate account of precipitation and temperature will be kept. This will be instructive as well as interesting to compare with the field data each season.

In addition to the study of different methods of rotation, a study of the actual moisture content in the different plats has

been started. This is to determine what effect, if any, the crops have upon the moisture in the soil, especially a corn crop. Small composite samples, in foot sections are taken to a depth of three feet on every plat. These samples are brought to the Experiment Station, where they are dried and the moisture content determined. This has been done three times during the season, viz: shortly after the crop was seeded, during the summer, and shortly after the crops had been harvested. However, the appliances I had to work with were far from satisfactory, as some of the moisture evaporated while on the road, due to the tin trays not being air tight. For this reason the absolute amount of moisture in the soil could not be determined. Another year air-tight glass jars will be purchased and used for this purpose.

GREAT NORTHERN DEMONSTRATION FARMS.

During the spring and early summer the precipitation was very heavy. This gave all kinds of crops a very good start. A thrifty growth continued through the summer. Had it not been for a few days of very hot winds just before harvest the yield of grain would have been much greater. The season as a whole was very favorable.

The method of Rotation mapped out for a period of five years at Ross, Granville and Lakota is as follows:

ROSS, WARD COUNTY.

1

'06 corn
'07 flax
'08 durum wheat (clover)
'09 clover
'10 oats or barley

2

'06 flax
'07 durum wheat (clover)
'08 clover
'09 oats or barley
'10 corn

3

'06 durum wheat (clover)
'07 clover
'08 oats or barley
'09 corn
'10 flax

4

'06 clover (with oats)
'07 oats or barley
'08 corn
'09 flax
'10 durum wheat

5

'06 barley or oats
'07 corn
'08 flax
'09 durum wheat (clover)
'10 clover

GRANVILLE, McHENRY COUNTY.

1

'06 corn
'07 flax
'08 durum wheat (clover)
'09 clover
'10 oats or barley

2

'06 flax
'07 durum wheat (clover)
'08 clover
'09 oats or barley
'10 corn

3

'06 clover (with oats)
'07 oats or barley
'08 corn
'09 flax
'10 durum wheat

4

'06 durum wheat (clover)
'07 clover
'08 oats or barley
'09 corn
'10 flax

5

'06 oats or barley
'07 corn
'08 flax.
'09 durum wheat (clover)
'10 clover

LAKOTA, NELSON COUNTY.

1

'06 corn
'07 flax
'08 oats or barley (with clover)
'09 clover
'10 wheat

2

'06 flax
'07 oats or barley (with clover)
'08 clover
'09 wheat
'10 corn

3

'06 oats or barley (with clover)
'07 clover
'08 wheat
'09 corn
'10 flax

4

'06 clover (plowed down in fall)
'07 wheat
'08 corn
'09 flax
'10 oats or barley (with clover)

5

'06 wheat
'07 corn
'08 flax
'09 oats or barley (with clover)
'10 wheat

From the above rotations it will be noticed that there are at least three marketable grain crops every year; wheat, oats or barley and flax. With corn and clover to clean the ground from weeds, enrich the soil, and in addition have the fodder crops for feed.

The following table shows the amount of moisture in per cent on the different plats when taken:

MOISTURE DETERMINATION.

ROSS, N. D.

Kind of crop	Date taken	Average for 3 ft. percent	Date taken	Average for 3 ft. percent	Date taken	Average for 3 ft. percent
Oats	May 18	20.00	July 17	14.52	Sept. 5	15.90
Oats & Clover*	"	20.88	"	14.02	"	13.74
Wheat & Clover	"	20.68	"	16.53	"	13.34
Flax	"	18.97	"	21.15	"	16.10
Corn	"	18.69	"	23.65	"	18.11

*Oats cut for hay.

GRANVILLE, N. D.

Barley	May 19	12.32	July 18	11.16	Sept. 6	8.31
Oats & Clover*	"	16.09	"	13.57	"	9.88
Wheat & Clover	"	11.21	"	5.18	"	3.89
Flax	"	13.86	"	6.52	"	4.19
Corn	"	12.58	"	16.71	"	4.69

*Oats cut for hay.

LAKOTA, N. D.

Wheat	May 20	43.65	July 19	20.19	Sept. 7	13.02
Oats & Clover	"	32.73	"	17.54	"	13.57
Oats, bar'y & clover	"	34.62	"	18.23	"	12.42
Flax	"	22.31	"	29.34	"	14.06
Corn	"	26.34	"	24.44	"	17..36

From the above tables it is interesting to note that, at the time of making the first moisture determination, the corn plats at the different stations, stood very low in percentage of moisture when compared with the other plats. But at the second time of taking the samples the corn plats stood first in moisture content, except at Lakota, where it stood second. Again at the third taking of the samples the corn plats stood first in moisture content except at

Granville, where the moisture in the corn plat stood very low. This, I believe, can be attributed to the fact that after the corn was too high to cultivate considerable Russian cactus started, making luxuriant growth, necessarily taking considerable moisture out of the soil, during the dry hot days in August. However, when the average moisture content of all the corn plats, wheat plats and oat plats are compared on the three farms, it will be seen that at the first determination the corn plats stood lowest, in moisture, while at the second and third determinations the corn plats stood first.

The following table gives the averages in per cent:

	First Determination Percent	Second Determination Percent	Third Determination Percent
Average for the 3 corn plats	19.20	21.60	13.39
Average for the 3 oat plats	23.23	15.21	13.12
Average for the 3 wheat plats	25.18	13.97	10.08

That the corn plats had more moisture during the latter part of the summer, I attribute to the fact of the cultivation they received, which kept the upper layer of soil loosened and greatly prevented evaporation to take place.

The notes taken during the season on the growing crops are given below and are self explanatory.

LAKOTA, N. D.

Elevation—1,520 feet.

Chas. Pettes, owner.

All the ground used for these experiments, was broken about 1887 and cropped continually to small grains with an occasional summer fallow.

The plat used for corn this year had macaroni wheat and potatoes upon it in 1905. It had been fresh manured during the winter of 1906. May 19th the plat was spring plowed four inches deep and immediately harrowed down. On acount of the abundance of straw in the manure, the ground did not pack readily, although the heavy rains aided this materially. On June 6th the plat was planted to corn, three to five kernerls per hill, with a check planter. The cool weather and wet soil prevented the corn from making much growth during June, but later it made a thrifty growth, reaching a height of four to five feet, at the time of frost. May 21st the plat was harrowed again, and on the dates of July 1, 4, 18, and 26, it was cultivated thoroughly, leaving the

ground in good condition and practically free from weeds. As there was no show of it maturing, the corn was cut and fed green to dairy cows. Due to neglect no weights were taken, to determine the amount of fodder per acre.

The oats and clover plat, was simply used to get the clover effects upon the ground. The oats was sown at the rate of one bushel per acre on May 10th and the clover was seeded on the same date at the rate of fifteen pounds per acre with the grain drill. On May 20th the clover was just coming up. The clover reached a height of four to six inches. About July 15th the plat was cut for hay. Again no weights were taken. On October 2nd it was plowed from five to six inches deep, and harrowed November 2nd. At that late date the clover was still green and thrifty, but I noticed the ground was rather dry and cloddy.

The plat having the fife wheat upon it, was summer fallowed rather shallow in 1905. In 1906 it was disced several times and dragged before seeding to kill the weeds. This put the land in excellent condition. On May 1st the plat was seeded to Scotch fife wheat, which had been treated to kill the smut. The wheat came up in good condition, stooled well, and made a heavy growth, reaching a height of three to three and a half feet in July. There was a slight trace of red and black rust. On August 18th it was practically ripe and was harvested August 22nd. Both the grain and straw were in excellent shape. When threshed it yielded 15.8 bushels per acre of wheat weighing 59 pounds and graded No. 1 Hard on the market.

The flax plat had durum wheat upon half of it and the other half was fallowed in 1905. That part of it which grew durum wheat was manured during the winter of 1906 with fresh manure. On May 19th the plat was plowed and dragged. It was again dragged thoroughly May 21st. The plat was seeded to Egyptian flax June 14th which had not been treated. The ground had no further preparation. The stand of flax was irregular at first, but became more uniform, except a small portion of the field, which was very low. It was cut September 20th. When threshed it weighed out 6.8 bushels per acre by machine weight. The flax was of excellent quality.

The oats, barley and clover plat was summer fallowed in 1905. In the spring of 1906 it was disced several times and dragged thoroughly on May 3rd. This plat was divided into two parts; one half was sown to barley and one half to oats on May 3rd. The clover was seeded broadcast with a drill at the rate of fifteen pounds per acre, by taking the tubes out of the shoes and scattering over the ground, then dragging immediately afterwards. The plat received no further cultivation. Both the oats and barley

came up well and made a thrifty growth. I noticed that the stand of clover in the barley was a little heavier and longer than on the oat portion. The barley was cut August 10th and when threshed it yielded 25 bushels per acre of good quality. The oats yielded 47 bushels per acre of No. 2 white, oats weighing about forty pounds per bushel. I believe that the discing and harrowing of these plats before seeding practically killed all of the weeds then started, leaving a clean mellow seed bed.

The following table gives the field data summarzied:

Kind of crop	Date of seeding	Rate of seeding	Length of straw	Percent rust	Yield per acre	Wgt. per bushel	Grade
Wheat	May 1	1-¼ bu.	36 in.	trace	15.8 bu.	59	No. 1 Hard
Oats & Clover	May 10	1 bu.	42 in.	0	cut for hay		
Oats		2 bu.	48 in.	0	47 bu.		
Barley & Clover	3	2 bu.	30 in.	0	25 bu.		
Flax	June 14	½ bu.	18 in.	0	6.8 bu.		
Corn	" 6	3—5 kernels	56 in.	0	not weighed		

GRANVILLE, N. D.

Elevation—1,116 feet.

C. A. Stubbins, owner.

The ground used for these experiments was old cultivated land and evidently had not received the best treatment. It had produced macaroni wheat in 1905, and had been fall plowed from four to six inches deep. This had been done very poorly, consequently the land required considerable harrowing in the spring of 1906 to get the field into shape. Again the ground was very foul with weeds, which troubled the grain more or less all summer.

The ground selected for corn was planted May 23rd to Mercer Flint with a check row planter from three to four kernels per hill. It came up very uniformly, and grew rapidly, having reached a height of two feet by July 18th. The corn ground was harrowed four times and cultivated deep four times during the season, which kept the ground clean, but after it got too high to cultivate, cactus took possession of the ground and made a very large growth. August 17th the corn averaged about forty-eight inches high. About the 20th of September the ears were fully matured. The corn was cut with a binder, dried, and weighed, averaging 2,936 pounds per acre. Enough ears was saved for seed.

On May 1st the flax was sown at the rate of one half bushel per acre. It came up very thick, but the weeds started at the same time. Later the flax thinned out; but not due to any disease,

as near as could be noticed. At the time of harvest August 16th, the flax had reached a height of twenty-four inches; the bolls, however, were rather small. When threshed it yielded 10.5 bushels per acre of No. 1 flax.

The barley was seeded April 26th at the rate of two bushels per acre. On May 19th it was about three inches high, the stand of barley was good, but the ground was getting weedy. July 18th it ranged from two and one-half to three feet high, all headed out. It had now outgrown the weeds fairly well. The barley stood up well, and was free from rust. July 28th it was harvested and later stacked. When threshed it yielded 25 bushels per acre.

The oats and clover plat was in the same condition as the others in that it was in poor shape. They were both seeded with the drill on April 25th at the rate of one bushel of oats and fifteen pounds of clover per acre. The plat was seeded about two and one-half inches deep; both came up in good condition, but the oats soon covered the clover up. July 18th the oats averaged about three feet high, and headed out. There was no rust and practically no smut. This seed was treated. A very noticeable difference could be seen between this oats and the general farm oats which had not been treated for smut. July 27th it was cut for hay, and yielded 2,772 pounds per acre. The height of the clover ranged from one to five inches high at the time of cutting, showing considerable irregularity.

The macaroni wheat and clover was seeded about two and one-half to three inches deep, on April 25th at the rate of one bushel of wheat to fifteen pounds of clover. The wheat came up rather thin, as would be expected. The clover came up fairly thick, but was soon outgrown by the wheat. The ground became rather weedy. July 18th the wheat had reached a height of two and one-half to three feet. There was a small amount of red rust upon the leaves, but none on the stem. The clover seemed to be getting thinner and made very little growth. August 16th the wheat was cut and shocked, and yielded 14 bushels per acre of No. 1 macaroni. On account of the clover on this plat being so poor, it was plowed down instead of the oat and clover plat as planned.

The following table gives a summarized statement:

Kind of crop	Date of seeding	Rate of seeding	percent rust	Length of straw	Yield per acre	Wgt per bushel	Grade
Barley	Apr. 26	2 bu.	0	30 in.	25 bu.	46.0	No. 2 F.
Oats & Clover	Apr. 26	1 bu.	0	36 in.	2,772 pounds of hay.		
Wheat & Clover	Apr. 25	1 bu.	trace	36 in.	14 bu.	62.5	No. 1 Mac.
Flax	May 1	½ bu.	0	18 in.	10.5 bu.	50.0	No. 1
Corn	May 23	3 to 4 ker	0	48 in.	2,936 pounds corn.		Fodder

ROSS, N. D.—Elevation 2,291 feet.

R. H. McEnany—owner.

The land at Ross has only been under cultivation for a few years, making it practically new land. In 1905 the land was put into flax and fall plowed in the latter part of October about three inches deep. In the spring of 1906 the land was harrowed several times, yet it was rather soddy thru the season.

The corn ground was disced twice and harrowed twice. It was then planted by hand May 15th at the rate of four to six kernels per hill, using Mercer Flint. Then harrowed once after planting. On account of the cold wet weather the corn layed four weeks in the ground before it came up. On the dates of June 16th and 20th the field was again harrowed. On June 28th and July 10th and 24th the ground was cultivated shallow, leaving the ground in excellent condition. July 17th the corn was about ten inches high, and appeared very thrifty though late. August 18th it was thirty-eight inches high, and just tasseling. September 5th it had reached a height of about fifty-one inches. Though the frost did not hurt it until September 29th it was too late to mature the ears. October 2nd it was cut and shocked in good shape. When dried out, one load of shocks was weighed and the yield estimated from that, yielding 3,329 pounds of air dry fodder per acre.

The oats and clover plat was sown April 24th at the rate of one bushel per acre and about fifteen pounds of clover per acre. The clover was seeded by hand and dragged in. The oats came up fairly thick and thrifty, but it was not as thick as the oats alone. The clover also came up fairly well, but made very little growth. On July 18th the oats averaged thirty-four inches high and fully headed out, while the clover ranged from one to two inches high, being a little thin and yellowish in color. July 20th the oats was cut for hay, and stacked in the field. After the stack had settled, it measured out slightly over ten tons of hay, or about 5,000 pounds per acre. The clover made very little growth thereafter.

The flax plot was harrowed thoroughly before seeding. It was seeded April 24th at the rate of one-half bushel per acre. The flax was of the Argentine variety. May 18th it was just showing its first set of leaves. During the first part of the season the stand was thick and growing rapidly, but later the flax plants began to dry up just above the ground and die, due to a fungus disease, having similar habits to the flax wilt. About five per cent was destroyed. This was the third crop of flax upon the ground. On July 17th the flax was eighteen inches high and all headed out. There was a small amount of mustard in the field, which was soon afterwards pulled out. August 16th it was about twenty-four inches

high, heavily bolled, and practically ripe. It was harvested August 28th and not threshed until September 29th; yielding 8.2 bushels per acre of No. 1 flax.

The oats was sown April 24th at the rate of two bushels per acre. May 18th it was two and one-half inches long and a very heavy stand. July 17th it measured thirty-six inches high, and fully headed out. It was free from rust and smut. At the time of harvesting August 13th the oats measured forty inches high. It threshed 73.4 bushels per acre of heavy oats.

The plat having wheat and clover was seeded to macaroni wheat April 24th at the rate of one and one-half bushels per acre. Through a misunderstanding the clover was not seeded until May 30th, when it was sown by hand and harrowed in. This made it rather severe on the clover as the wheat covered the ground before the clover came up. On May 18th the wheat was about two inches high, and July 17th it ranged from two and one half to three feet high, and fully headed out. No rust of any kind was visible. The clover at this time was only about two inches high, and quite thin, but appeared very healty. It made very little growth the rest of the season. August 13th the wheat was cut and shocked in good shape. The kernels were somewhat shrunken. It yielded 21.1 bushels of No. 2 Macaroni per acre. This yield was not enough for the heavy stand of straw, though the kernels were not plump. I believe some of the grain went into the straw pile.

Below is a table giving a summarized statement:

Kind of crop	Date of seeding	Rate of seeding	Percent rust	Length of straw	Yield per acre	Wgt. per bushel	Grade
Oats	April 24	2 bu.	0	40 in.	73.4 bu.	35	No. 3 W.
Oats & Clover	April 24	1 bu.	0	40 in.	5,000 pounds hay		
Wheat & Clover	April 24	1-½ bu.	0	36 in.	21.1 bu.	58-½	No. 2 Mac.
Flax	April 24	½ bu.	0	24 in.	8.2 bu.	50	No. 1
Corn	May 17	4 to 6 ker	0	60 in.	3,329 pounds fodder		

King in his Physics of Agriculture, summarizing experiments performed by Hellriegel, states that twelve inches of effective rain during the growing season of wheat, starting with the soil moisture in good condition, should enable a yield of forty bushels per acre to be produced, or twenty-five bushels of wheat would require 7.497 inches of rain, on the same basis. From this statement I would judge that the rain should fall at critical times and the soil should have sufficient humus to hold the water and carry it over periods of drouth.

Though our climatic conditions may vary from the place where

these experiments were made, yet we find that by comparing the rain fall for the growing season—the months of March, April, May, June, July and August—with the above, we usually have sufficient for that amount of grain as will be seen from the following Precipitation Table, taken from Fort Buford-Williston weather report records for a period of thirty years.

FORT BUFORD AND WILLISTON.

Year	PRECIPITATION Mar., Apr., May, June, July, Aug.	PRECIPITATION Annual	Year	PRECIPITATION Mar., Apr., May, June, July, Aug.	PRECIPITATION Annual
1875	11.94	14.85	1890	9.27	14.24
1876	9.89	12.34	1891	14.45	18.98
1877	7.58	12.29	1892	11.03	14.26
1878	Incomplete	Incomplete	1893	9.29	15.45
1879	12.50	19.67	1894	12.88	17.76
1880	16.96	23.25	1895	12.86	17.06
1881	9.37	14.90	1896	15.84	22.04
1882	7.52	12.73	1897	8.51	12.19
1883	6.60	10.82	1898	10.36	14.44
1884	5.46	7.37	1899	9.97	12.61
1885	13.33	15.56	1900	10.94	15.81
1886	7.36	10.24	1901	13.72	18.36
1887	11.96	15.43	1902	13.19	16.85
1888	12.53	14.74	1903	14.33	17.69
1889	6.10	8.46	1904	7.33	9.94

At the above station in twenty-nine years, the required precipitation fell short five years. If King's method of estimation is anywhere near correct, the rainfall that we have at Williston is usually amply sufficient for a bumper crop. Then the fault of many of our light crops surely lies in the soil or in the cultivation of the soil. That the native soil usually has sufficient plant food has been proven by chemical analysis, and that under constant cropping the soil has been robbed of a large portion of its fertility. Hence there seems to be but one thing to do, restore the fertility by manuring and cultivation and it is to this end that the demonstration farms are working.

It is believed by many of our old settlers that the annual precipitation in this state is gradually increasing. That the increased cultivation of the land has been the main factor in doing so. And on this account we will have no more of such drouths as we have had in the past.

By taking the annual precipitation for the last thirty years as given in the report, and dividing it into two fifteen year periods, we find that at Fort Buford-Williston, there is an average increase of 2.08 inches in the last fifteen years over the fourteen years previous.

This is not as large an increase in the precipitation as would be expected. The following statement shows the average precipitation.

'74 to '90 13.76 inches (14 years.)
'89 to '05 15.81 inches.

Again the idea is prevalent that our growing season has lengthened. That is, the time between the last killing frost in the spring and the first killing frost in the fall. In looking up the weather reports at Fort Buford-Williston for the twenty-three years that I had record of indicates that there is a great variation in the time between killing frosts and that there is no regularity in the increase or decrease in the length of the growing season as shown in the following table:

SHOWING FIRST AND LAST KILLING FROSTS, DURING THE GROWING PERIOD AT FORT BUFORD-WILLISTON.

Year	Last Killing Frost Spring Mo. Date	First Killing Frost Fall Mo. Date	No. of Days Between Frosts	Year	Last Killing Frost Spring Mo. Date	First Killing Frost Fall Mo. Date	No of Days Between Frosts
1882	May 23	Sept. 9	109	1894	Incomplete	Sept. 10	
1883	June 2	Aug. 22	81	1895	May 20	Sept. 7	110
1884	May 5	Sept. 30	148	1896	Apr. 24	Sept. 10	139
1885	May 11	Sept. 1	113	1897	May 14	Oct. 8	147
1886	May 14	Sept. 16	125	1898	May 6	Sept. 9	126
1887	May 17	Sept. 15	121	1899	May 17	Sept. 29	135
1888	May 16	Sept. 25	132	1900	May 16	Sept. 27	134
1889	May 9	Sept. 11	125	1901	May 12	Sept. 17	128
1890	May 26	Sept. 12	109	1902	Apr. 29	Sept. 12	136
1891	May 15	Incomplete		1903	June 10	Sept. 14	96
1892	May 26	Aug. 30	96	1904	May 26	Sept. 11	108
1893	May 25	Sept. 23	121				

At Fort Buford and Williston in 1902, the periods between frosts was 136 days; in 1903 it dropped to 96 days, then in 1904 it went up to 108 days again. The longest period between frosts was in 1884 being 148 days and in 1897 there was 147 days between frosts, again showing no regularity in the time. By taking the same years in ten year periods from 1882 to 1894 (leaving the year 1891 out) the average time between frosts was 117.1 days, while from 1894 to 1905, the time between frosts was 125.9 days. Showing a difference of 8.8 days in favor of the last ten years.

E. G. SCHOLLANDER,
Superintendent.

Northern Pacific Demonstration Farms

To J. H. Worst, Director:

Sir: The season has been a very favorable one. The precipitation has been abundant and coming at short intervals during the growing period, made an almost ideal growing season for all kinds of crops, and consequently fair yields have been obtained on the plats as well as on the farms in the neighborhood.

The method of rotation is similar to that mapped out on the Great Northern Line, except that field peas, instead of clover was introduced at New Salem. This was done to enable us to note what effect peas will have upon the soil. Three marketable grain crops are planned to be produced every year, with corn and field peas to clean the land and enrich the soil. The plat for the clover and peas shall be manured, previous to seeding every year. This is to aid the Legumes in making a quick thrifty growth.

The method of rotation mapped out for a five year period at Bismarck, New Salem and Beach are as follows:

BISMARCK, BURLEIGH COUNTY.

1	2
'06 fife wheat	'06 oats (clover with oats plowed down)
'07 barley (clover with barley-manured)	'07 flax
'08 clover	'08 corn
'09 flax	'09 fife wheat
'10 corn	'10 barley (clover with barley-manured)

3	4
'06 barley (clover with barley-manured)	'06 flax
'07 clover	'07 corn
'08 flax	'08 fife wheat
'09 corn	'09 barley (clover with barley-manured)
'10 fife wheat	'10 clover

5

'06 corn
'07 fife wheat
'08 barley (clover with barley-manured)
'09 clover
'10 flax

NEW SALEM, MORTON COUNTY.

1

'06 corn
'07 fife wheat
'08 peas and oats (manured)
'09 durum wheat
'10 oats

2

'06 durum wheat
'07 oats
'08 corn
'09 fife wheat
'10 peas and oats (manured)

3

'06 fife wheat
'07 peas and oats (manured)
'08 durum wheat
'09 oats
'10 corn

4

'06 peas and oats (manured)
'07 durum wheat
'08 oats
'09 corn
'10 fife wheat

5

'06 oats
'07 corn
'08 fife wheat
'09 peas and oats (manured)
'10 durum wheat

BEACH, BILLINGS COUNTY.

1

'06 corn
'07 wheat
'08 wheat (clover with wheat-manured)
'09 clover
'10 oats

2

'06 wheat
'07 wheat (clover with wheat-manured)
'08 clover
'09 oats
'10 corn

3

'06 wheat (clover with wheat-manured)
'07 clover seeded again
'08 oats
'09 corn
'10 wheat

4

'06 clover with oats
'07 oats
'08 corn
'09 wheat
'10 wheat (clover with wheat-manured)

5

'06 spelt and brome grass
'07 corn
'08 wheat
'09 wheat (clover with wheat-manured)
'10 clover

The following table gives the dates of taking the soil samples and the percent of moisture in the different plats, when taken. This occurred shorty after the crops were seeded, during the summer and after the crops were harvested.

MOISTURE DETERMINATION.

Kind of Crop	Date Taken	Average for 3 ft per cent	Date Taken	Average for 3 ft per cent	Date Taken	Average 3 ft per cent
BISMARCK						
Wheat	May 5	16.41	July 28	11.54	Aug. 30	6.36
Oats & Clover	"	8.65	"	5.89	"	6.93
Barley & Clover	"	10.14	"	5.94	"	8.37
Flax	"	8.39	"	7.56	"	5.76
Corn	"	9.86	"	12.11	"	10.63
NEW SALEM						
Oats	May 9	12.22	July 27	7.52	Aug. 30	9.23
Oats & Peas	"	14.82	"	7.49	"	10.97
Fife wheat	"	19.05	"	8.43	"	13.41
Mac. wheat	"	19.04	"	10.44	"	10.02
Corn	"	16.19	"	11.33	"	15.83
BEACH						
Spelt & Brome	May 7	13.88	July 26	8.02	Aug. 29	14.62
Oats & Clover	"	18.37	"	13.10	"	13.80
Wheat	"	11.96	"	8.01	"	15.69
Wheat & Clover	"	13.44	"	7.67	"	10.40
Corn	"	14.48	"	19.40	"	17.85

In examining the above table it will be seen that, when the first determination was made, the corn plats stood lower in percentage of moisture than some of the adjoining plats. At the second and third time of making the determination, however, the corn plats stood highest in moisture content, on each farm.

By comparing the average moisture in the corn, wheat and oat plats, on the three farms, at the first, second and third determination as shown in the following table, it will be noticed that at the first determination the corn plats stood lowest, but at the second and third determination they stood highest. Where there was more than one plot of wheat or barley on a farm the one having the highest percent of moisture was used in making the average.

	First Determination	Second Determination	Third Determination
Average of the 3 corn plats	13.51	14.28	14.77
Average of the 3 wheat plats	13.95	8.84	10.57
Average of the 3 oat plats	16.30	10.00	11.82

This indicates plainly that altho a corn crop takes an enormous amount of water out of the soil, for its growth, during the season, it had more moisture at the second and third time of taking samples than any of the others. This can only be attributed to the fact, that constant surface cultivation tends to preserve the moisture in the soil. This fact has already been demonstrated at the Fargo Station, but was critically accepted in the drier sections of the state.

Samples of grain in the straw and threshed, have been saved from the different plats on the three farms. These will be kept at the Fargo Station for exhibiting purposes.

The grain was of good quality and the yields fair. It was threshed out of shock at Beach and New Salem. At Bismarck it was stacked and allowed to sweat before being threshed. The rust did very little damage and wherever the seed was treated before planting it was practically free from smut.

Below are given notes and results obtained on the different farms during the season.

BISMARCK, N. D.

Elevation—1,670 feet

Joseph Hare, owner—N. F. Boucher, Manager.

The precipitation for the months of April, May, June, July, August and September in 1906 was 14.79 inches. In 1905 the

ground at Bismarck had been spring plowed and sown to oats. In the spring of 1906, after being laid out for demonstration purposes, it was again spring plowed, ranging from April 18th to May 20th, when the corn ground was plowed. The ground was medium moist and mellow, making a good seed bed, and was practically free from weeds. The dates of seeding and rates per acre is shown in the rotation table. The stand of all the grain and corn was excellent throughout the season.

The plat of corn was planted to Northwestern Dent on May 20th with a check row planter. About June 1st, just after coming up, it was harrowed, then cultivated thoroughly four times during the season, the last time July 15th. On June 7th the corn averaged four inches high and was very thrifty. July 28th it averaged 44 inches high and was just tasseling, the stand being extra heavy. September 3rd when cut, it had reached a height of 60 inches. The ears were perfectly ripe, fairly large and yielded 39.7 bushels per acre. This corn will undoubtedly be saved for seed. The fodder yielded 5,789 pounds per acre of air dry fodder.

The barley and clover ground was plowed, harrowed and seeded May 1st, both being seeded with the drill. The barley at the rate of two bushels and clover fifteen pounds per acre. The barley came up fairly thick though somewhat irregular and kept the clover down. On June 27th the barley stood from 6 to 10 inches high; the clover one inch high and fairly thick. July 28th, it ranged from 24 to 30 inches high, still very irregular. It was of the six-rowed type, stood up well and was free from rust. July 30th it was harvested. When threshed it yielded 26¾ bushels per acre of a fair quality of barley.

The plat of fife wheat was seeded April 18th. On June 27th the wheat had reached a height ranging between 10 to 24 inches, being somewhat irregular. It was a very heavy growth. On July 28th it had reached a height of 30 inches and fully headed out. It was badly affected by black and red rust, so much so, that the heads had a dark dull greenish hue. It was also a trifle smutty. The wheat was harvested September 5th. When threshed it yielded 22½ bushels per acre of No. 1 Northern.

The flax ground was plowed and harrowed May 16th. The flax was seeded on the same day at the rate of ½ bushel per acre. It came up fairly thick and continued so throughout the season. The ground remained exceedingly free from weeds. On June 27th the flax ranged from 2 to 5 inches high. July 28th it ranged in height from 14 to 21 inches and fully bolled. There was no sign of any disease. The flax was harvested September 5th and yielded well for old land as shown in the table.

The oats and clover plat was plowed, harrowed and seeded

April 28th. The ground being in the same condition as the barley plat. The oats was sown at the rate of two bushels and the clover fifteen pounds per acre. The oats made a luxurant growth, thus keeping the clover down. On June 27th the oats was from six to ten inches high, while the clover was from one to three inches high and seemingly a little thinner than the clover in the barley. July 23rd the oats ranged from thirty to thirty-six inches high, and fully headed out, while the clover was very short. The oats was badly smutted as it had not been treated. On account of the poor stand of clover, we plowed this plat down instead of the barley ground. The oats was harvested September 5th, and when threshed yielded 42 bushels per acre.

The work on these plats, was done very carefully and accurately. On account of having access to a scale the straw as well as the grain was weighed on the different plats. The following table gives a detailed account of the data.

Kind of Crop	Date of Seeding	Rate of Seeding	Per cent Rust	Height of Straw	Yield per Acre	Wgt. Per Bu.	Grade
Fife	Apr. 18	1-¼ bu.	heavy black	33 in.	22.5 bu.	56	No. 1 N.
Oats & Clover	Apr. 28	2 bu.	0	40 in.	42 bu.	37	No. 2 W.
Barley & Clover	May 1	2 bu.	0	31-¾ in.	26.8 bu.	43	No. 3 Feed
Flax	May 16	½ bu.	0	17 in.	14.3 bu.	53	No. 1
Corn	May 20	5 kernels	0	60 in.	39.7 bu. 5,786 lbs. fodder.		

NEW SALEM, N. D.

Elevation—2,160 feet.

John Christiansen, owner.

The ground was spring plowed six inches deep, ranging from the 23rd of April to the 12th day of May, when the corn plat was plowed. The ground was moist and mellow.

On May 18th and 19th the corn was planted from four to five kernerls per hill. During the last of May and particularly all of June the ground was very wet. On this account the corn made very little growth. The ground was too wet even to keep clean. On June 1st and 2nd the corn ground was harrowed, and on June 19th and 20th the ground was cultivated, again on June 26th and 27th and July 5th and 7th. On July 3rd and 7th the field was hand hoed. On June 25th the corn stalks measured six to eight inches high. On July 27th, 38 inches high. On August 10th 66 inches

high, September 17th, 77 inches high. October 3rd the corn was harvested, and practically all ripe. The corn yielded 29.7 bushels of ears and 5,763 pounds of fodder per acre. This corn was of the Golden Dent variety and will be saved for seed.

The fife wheat was seeded April 28th, and came up quite thin. During the month of June it was badly affected with red rust. On June 25th the wheat averaged six inches high, but there was an unusual amount of dead leaves, probably due to the rust. July 27th the wheat averaged twenty-seven inches high, and fully headed out. I noticed that there were two kernels in a mesh in the heads. There was still plenty of red rust, and also a small amount of black rust on the leaves. It was on the whole a rather poor stand for this season, when threshed it yielded 16¼ bushels per acre.

The durum wheat was also seeded on April 28th at the rate of 1¾ bushels per acre. It came up fairly thick and remained an excellent stand through the season. This was also attacked by the red rust, but nearly recovered. No black rust was noticed. On June 25th the wheat averaged ten inches high, and July 27th it averaged thirty-four inches high, the heads being well filled. It was cut August 24th, when threshed it yielded 28½ bushels per acre, or 12¼ bushels more per acre than fife wheat.

The oats and peas plat was seeded on May 3rd at the rate of one bushel of oats and one and one-fourth bushels of field peas per acre. At first the peas made more headway than the oats, but later the oats overtook them in growth. On July 29th the field was cut for hay. The oats was well headed out and reached a height of forty inches and the peas reached a height of thirty inches. It was well podded and some of the peas was ripe. The two made a luxuriant growth and weighed out two tons per acre.

The oat plat was seeded on May 3rd at the rate of 1¾ bushels per acre. This was one peck less than is customarily sown. When it came up the stand was rather thin, and it remained so throughout the season. On June 25th it averaged ten inches high, the tops being dried out. July 27th the oats averaged thirty-four inches high. It was harvested August 18th. It yielded 39½ bushels per acre of good quality. The following table gives the field data:

Kind of Crop	Date of Seeding	Rate of Seeding	Per cent Rust	Length of Straw	Yield per Acre	Wgt. per Bushel	Grade
Oats	May 3	1-½ bu.	0	36 in.	38.5 bu.	40-½	No. 2 white
Oats & Peas	May 3	1 bu. 1-¼ bu.	0	40 in. 30 in.	4000 lbs of hay		
Fife Wheat	Apr. 28	1-½ bu.	slight red	36 in.	16.2 bu.	59-½	No. 1 N.
M. wheat	" 28	1-¾ bu.	"	40 in.	28.5 bu.	63	No. 1 Mac.
Corn	May 18	5 kernels	0	77 in.	29.7 corn 5,763 lbs. fodder.		

BEACH, N. D.

Elevation—2,750 feet.

C. E. Barber, owner

The ground selected for the experiments had a variety of crops in 1905. The land had only produced a few crops since it was broken. Part of the ground had oats, part of it had potatoes, and corn, and part of it which had been broken the same spring had flax. Most of it being fall plowed in September 1905. On account of renting the land so late in the season, most of it was seeded, when the plats were laid out, consequently, there were only two acres of corn planted. Enough ground adjoining it, was manured this fall to make the four acres for another year. The plat having brome grass and spelt was thrown out for 1907, for the reason that the owner did not want to destroy the brome grass, and another plat, having had a crop of oats upon it selected in its place. It was an excellent stand of brome grass.

The corn plat had oats upon it in 1905 and was plowed four inches deep in September. In the spring of 1906, it was disced twice and planted to Golden Dent corn April 12th, from three to four kernels in a hill. The corn came up evenly and quickly, but made very slow growth during the months of May and June. On June 25th it averaged only about three inches high. During the months of July and August it made very rapid growth, and at the time of cutting September 26th, it averaged about fifty inches high. The stand was even and very good, the ears as already stated did not mature, probably about one-tenth got fairly ripe. If the corn had made a rapid growth from the start, it would have undoubtedly ripened. The fodder yielded 3,750 lbs. per acre of dry fodder.

The spelt and brome grass plat had potatoes and corn in 1905. It was fall plowed six inches deep in September, then dragged twice in the spring before seeding. The plat was seeded about the 15th of April at the rate of one bushel spelt and fifteen pounds of brome grass per acre; both came up in good shape, the spelt being an extra heavy stand. On June 25th the spelt averaged twelve inches high and brome four inches high. July 26th the spelt averaged thirty-nine inches high; brome from four to ten inches high. There seems to be plenty of wild vetch in the field. When threshed it yielded sixty bushels per acre. The brome grass made a good and thrifty growth and will be kept for meadow and pasture.

The macaroni wheat and clover plat had fodder upon it in 1905. On May 5th, 1906, it was plowed five inches deep and disced April 1st. On April 4th it was seeded to wheat, and on April 24th the clover was sown by hand. The clover came up, but made very

little growth; the wheat on the other hand made a very heavy growth and remained so through the season. On June 25th the wheat was twenty inches high. On July 25th it ranged from thirty to thirty-six inches high. On August 11th it was harvested. At this time about five per cent of it was rusted and about one per cent smutted. The rust did very little damage, however, as it threshed out 35 bushels per acre of No. 1 Macaroni.

The macaroni wheat plat was into flax in 1905, then being breaking. It was disced twice April 1st, and seeded April 4th. This plat did not stand as heavy as the above plat at any time of the season. It was harvested on August 11th. It had about the same amount of rust and smut as the other plat. June 25th it averaged fourteen inches high and July 27th it ranged from thirty to thirty-six inches high. It only threshed 29 bushels per acre.

The oats and clover plat, had oats upon it in 1905, and fall plowed September 15th. It was dragged in the spring before seeding and sown to oats April 9th at the rate of two bushels per acre, and to clover April 16th at the rate of ten pounds per acre. The stand of oats was heavy and luxuriant. The clover was fairly thick but made very little growth. The oats was free from rust, but had about three per cent smut, and threshed 49½ bushels per acre of a very fine quality of oats. This farm produced the best average crop of the six farms. Below is a detailed table giving results:

Kind of Crop	Date of Seeding	Rate of Seeding	Height of Straw	Yield per Acre	Wgt per Bushel	Per cent Rust and Smut	Grade
Spelt & Brome	Apr. 15	1 bu.	41 in.	60 bu.	40	0	
Oats & Clover	Apr. 9	2 bu.	36-½ in.	49.5 bu.	38	rust-0 smut-3	No. 2 W.
M. wh't	Apr. 4	1-½ bu.	38-½ in.	29 bu.	60-½	rust-5 smut-1	No. 1 N.
M. wh't Clover	Apr. 4	1-½ bu.	38 in.	35 bu.	61	smut-1	No. 1 M.
Corn	Apr. 12	3 to 5 kernels	50 in.	3,750 lbs. fodder			

Professor King summarizing experiments performed by Hellriegel, states "that twelve inches of rain fall during the growing season of wheat, starting with the soil moisture in good condition, should insure a yield of forty bushels per acre to be produced, on the same basis 7.497 inches of rain should produce a yield of twenty-five bushels of wheat."

Though our climatic conditions undoubtedly vary from where the above experiments were completed, it is interesting to compare our own rainfall for the growing season, with that of the above experiment. For this purpose the following precipitation table, for

the growing season as well as for the year for the last thirty years, was prepared from the U. S. Weather Reports, taken at Bismarck.

BISMARCK.

Year	—PRECIPITATION— Mar. Apr. May Jnne, July, Aug.	Annual	Year	—PRECIPITATION— Mar. Apr. May June, July, Aug.	Annual
1875	19.13	27.52	1890	11.97	15.75
1876	21.05	30.92	1891	16.38	20.50
1877	13.71	17.68	1892	14.99	18.17
1878	17.06	20.23	1893	9.95	13.74
1879	18.78	20.61	1894	8.92	14.32
1880	17.26	19.75	1895	13.06	16.92
1881	12.11	15.76	1896	10.49	16.65
1882	16.73	21.33	1897	10.63	14.33
1883	9.24	15.66	1898	8.97	13.67
1884	16.41	23.36	1899	13.48	15.47
1885	10.73	13.08	1900	10.46	17.88
1886	9.07	13.26	1901	10.78	15.59
1887	11.45	16.33	1902	13.97	15.95
1888	13.14	16.51	1903	13.14	17.96
1889	7.73	11.03	1904	9.18	14.17

At Bismarck in thirty years, the required amount of rain to produce a 25 bushel crop during the six months of March, April, May, June, July and August did not fall below a single year, if King's method is to be considered. Seventeen years out of thirty, enough rain fell to produce forty bushels of wheat per acre. Allowing for some difference in the required rain fall, yet it ought not to warrant the great difference in bushels that should be grown and what has actually been produced. It leads to but one conclusion, and that is that past farming has not been of an intensive nature.

It is believed by many people that our annual precipitation is gradually increasing or in other words that the precipitation for the last fifteen years has increased over the fifteen years previous. The contrary is the fact at Bismarck as shown by the following figures:

'74 to '90 18.87 inches.

'89 to '05 16.07 inches.

It is also believed by many of our citizens that the time between the last killing frost in the spring and the first killing frost in the fall is lengthening. The data gathered from the weather reports, shows a great variation from year to year, as will be noticed from the following statement:

SHOWING LAST AND FIRST KILLING FROSTS, DURING THE GROWING PERIOD AT BISMARCK FOR TWENTY-THREE YEARS.

Year	Last Killing Frost Spring Mo. Date	First Killing Frost Fall Mo. Date	No. of Days Between Frosts	Year	Last Killing Frost Spring Mo. Date	First Killing Frost Fall Mo. Date	No. of Days Between Frosts
1882	May 23	Sept. 23	123	1894	May 3	Sept. 17	137
1883	" 11	" 28	140	1895	" 21	Aug. 31	102
1884	" 1	" 27	149	1896	" 1	Sept. 10	132
1885	" 9	" 1	115	1897	June 7	" 16	101
1886	" 15	" 18	126	1898	" 4	" 9	97
1887	" 17	" 15	121	1899	" 13	" 19	98
1888	June 6	" 12	98	1900	April 18	" 26	161
1889	May 14	" 26	135	1901	June 7	" 18	103
1890	" 15	" 13	121	1902	" 21	" 12	83
1891	" 5	" 25	143	1903	May 5	" 14	132
1892	" 4	" 5	124	1904	" 14	" 11	120
1893	" 27	" 16	112				

As will be seen at Bismarck in 1902, there was only 83 days apart between frosts; in 1903, 132 days apart; while in 1904 it dropped back to 120 days. The longest period between frosts was in 1900 when 161 days was recorded and 149 days in 1884; the longest period happened in late years, while the second was recorded in the early days of settlement. Taking the same years in ten year periods, from 1884 to 1895 the average time between frosts was 123.2 days; while from 1894 to 1905 the average time was only 112.9 days, being an average of 10.3 days per year in favor of the first ten years.

It is my intention to make a chemical analysis each winter for a few of the principle elements, such as potash, phosphoric acid and humus content of the soil on the different plats at each station. This it to note what effect the rotation and tillage will have upon the fertility of the soil. Soil samples have been saved for this purpose on each plat to a depth of eight inches. The work is slow and difficult but I believe that it will give valuable information, when completed at the end of the five year period.

At the close of the five year rotation, when the yield of grain, moisture content, and chemical analysis have been summarized at the different stations, some interesting and complete data on crop rotation should be forthcoming. Data that can not be obtained by any other method.

In conclusion, in summarizing the annual and growing season, precipitation, the time between killing frosts, for the year and for

the growing season, it will be noticed that there is practically no change for the last thirty years, at the two stations mentioned, though it is generally so believed. Hence we must take advantage of conditions as they are, by keeping up the fertility of the soil, and by methods of seed selection and cultivation, lessen the periods of maturity of such grains that rarely mature. Though we have sufficient of rain during the growing season to produce a 25 bushel wheat crop, by calculation, it will be wise to pursue such methods of rotation, that will conserve the moisture in the soil for the use of crops, as well as keep up the fertility, in case insufficient rainfall should again occur. With these objects in view, the work on the demonstration farms is carried on.

E. G. SCHOLLANDER,
Superintendent.

STATEMENT

Of Receipts and Disbursements from July 1st, 1905, to July 1st, 1906

RECEIPTS.

Received from U. S. Hatch Act of March 2nd, 1887	$ 15,000.00
" " " Adams Act of March 16th, 1906	5,000.00
Total	$ 20,000.00

DISBURSEMENTS.

Salaries	7,077.07
Labor	4,473.56
Publications	1,817.64
Postage and Stationery	290.31
Freight and Express	39.68
Heat, Light, Water and Power	367.16
Chemical Supplies	42.46
Seeds, Plants and Sundry Supplies	1,782.42
Feeding Stuffs	611.91
Library	11.41
Tools, Implements and Machinery	2,221.48
Furniture and Fixtures	59.40
Scientific Apparatus	209.94
Live Stock	500.00
Traveling Expenses	176.16
Contingent Expenses	15.00
Buildings and Repairs	304.40
Total	$ 20,000.00

C. E. NUGENT,
Accountant.